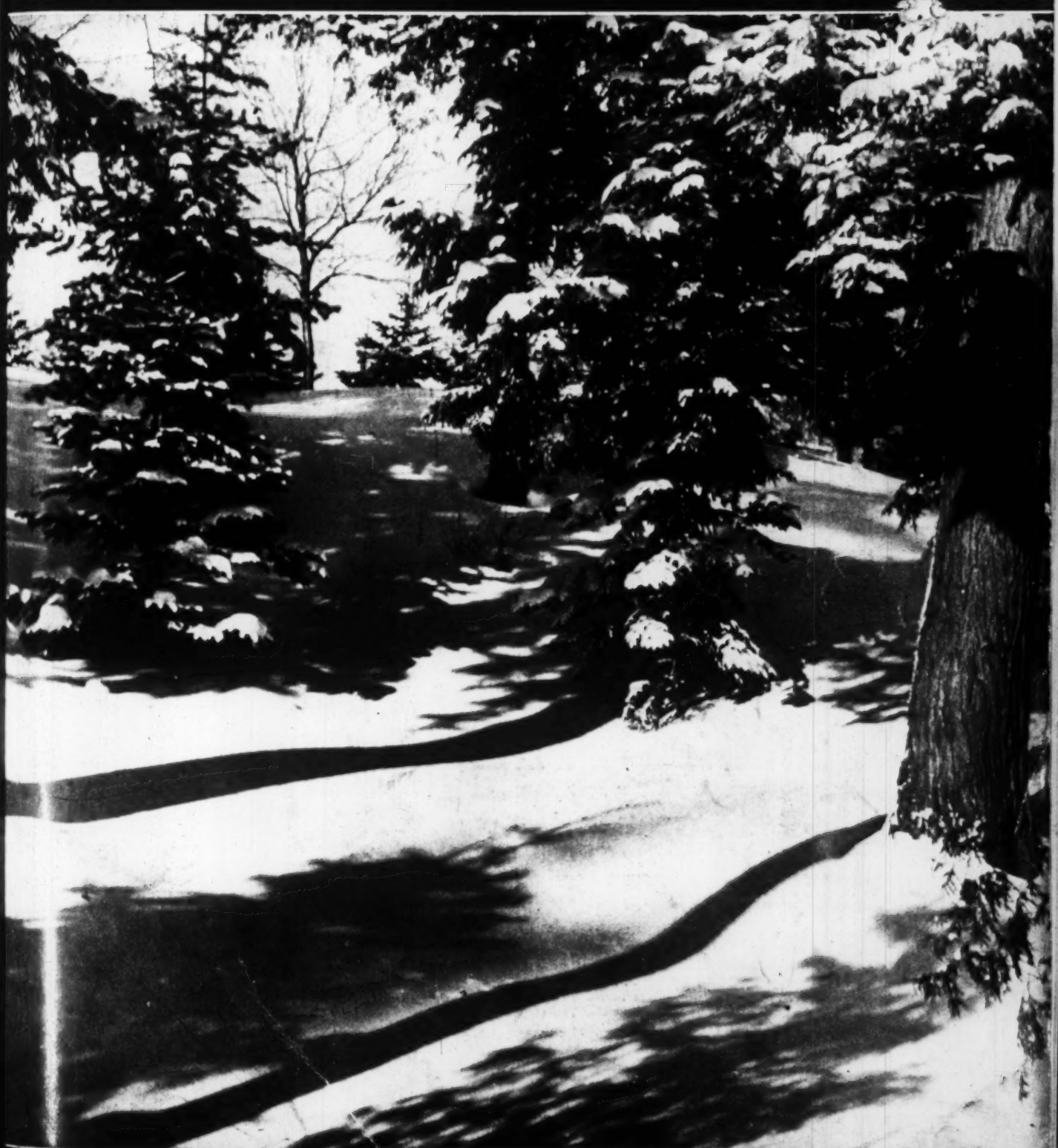
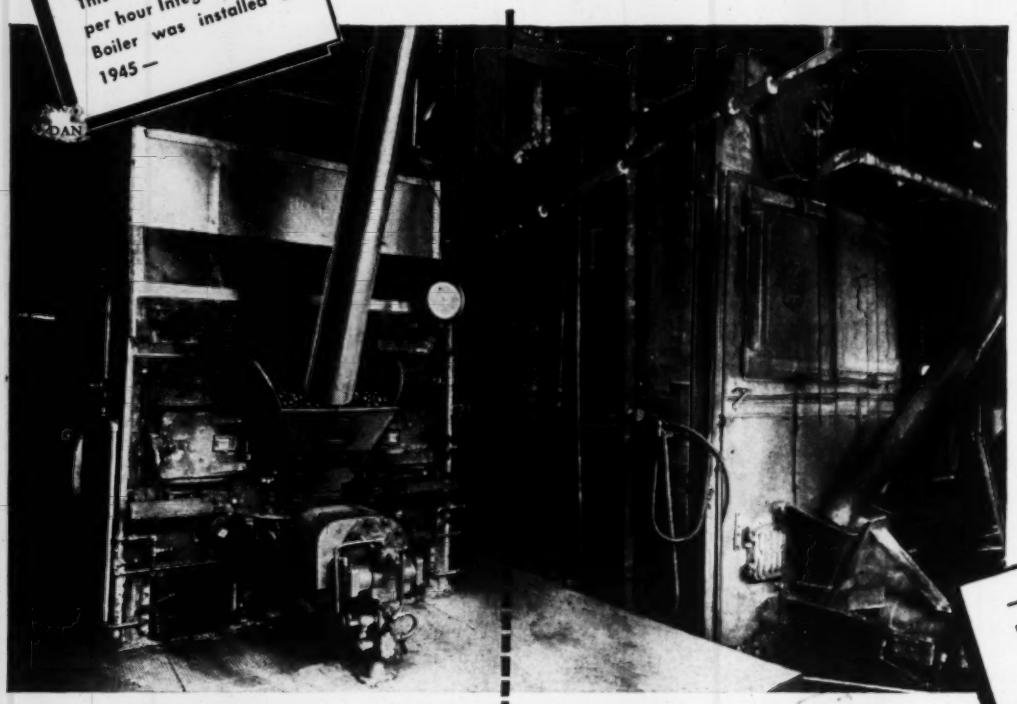
MECHANICAL ENGINEERING



DECEMBER 1946

44 YEARS' PERFORMANCE SELLS SATISFIED USER TWO *MORE* B&W's

This new B&W 16,000 lb. per hour Integral Furnace Boiler was installed in 1945—



—and another duplicate unit has replaced this original boiler, in service since 1901.

Distinctive Features of B&W Integral Furnace Boilers That Assure Faithful Performance:

1. Water-cooled furnace sidewalls and roof are of the same durable stud-tube construction used in large central-station boilers.
2. Deep furnace, fired from one end, provides ample space for complete combustion.
3. Bare metal blocks cover and protect the tubes of the water-cooled furnace floor, provide a surface readily cleared of ash.
4. Self-draining superheater design prevents accumulation of water in the tubes, and a stud-tube wall shields the second and third banks from direct furnace radiation.
5. Tubes of the third bank, which is in the zone of coolest gases, act as down-comers, insuring rapid, positive circulation at all loads.

Again it's the story of "satisfied customer comes back for more"...a story that has been an old one with B&W for many years.

Old, too, were the boilers the story's about—two B&W longitudinal-drum boilers purchased by The Lunkenheimer Company of Cincinnati back in 1901—and still in daily operation at the time they were removed for plant expansion only last year.

In testimony to the performance of these veterans, the two new units that replace them also bear the B&W name. They are modern B&W Integral-Furnace Boilers, a type that has won sweeping acceptance in almost every major industry for high availability and continuity of service...for rapid response to fluctuations in load demands...for the production of clean, dry steam...for over-all economy with all types of fuel.

G-322

Water-Tube Boilers, for Stationary Power Plants, for Marine Service . . . Water-Cooled Furnaces . . . Superheaters . . . Economizers . . . Air Heaters . . . Pulverized-Coal Equipment . . . Chain-Grate Stokers . . . Oil, Gas and Multifuel Burners . . . Seamless and Welded Tubes and Pipe . . . Refractories . . . Process Equipment.

BABCOCK & WILCOX

THE BABCOCK & WILCOX CO.
GENERAL OFFICES: 85 LIBERTY ST., NEW YORK 6, N.Y.
WORKS: ALLIANCE AND BARBERTON, O.; AUGUSTA, GA.

MECHANICAL ENGINEERING

Published by The American Society of Mechanical Engineers

VOLUME 68 NUMBER 12

Contents for December, 1946

THE COVER . . . . . *A Snow Scene—Photograph by Charles Phelps Cushing*

ENGINEERING IN AN ATOMIC ERA . . . . . *A. C. Klein* 1029

POWER—WHERE DO WE GO FROM HERE? . . . . . *H. A. Winne* 1032

WOOD-TO-METAL ADHESIVES . . . . . *T. D. Perry* 1035

PASSENGER-CAR ELECTRICAL AND HEATING EQUIPMENT . . . . . *H. H. Hanft* 1041

HYDROGEN PEROXIDE FOR PROPULSIVE POWER . . . . . *Logan McKee* 1045

MECHANICAL APPLICATIONS OF LATEX-DIP COATINGS . . . . . *F. W. Woerner* 1049

FLEXIBLE ORGANIC ADHESIVES AS STRUCTURAL ELEMENTS . . . . . *D. L. Loughborough and F. D. Snyder* 1053

SEAT COMFORT . . . . . *F. E. Randall* 1056

ENGINEERS AND INDUSTRIAL RELATIONS . . . . . *C. A. Myers* 1059

COLLECTIVE BARGAINING AT THE CROSSROADS . . . . . *Philip Taft* 1061

A REPORT TO THE COUNCIL OF E.C.P.D. . . . . *E. S. Lee* 1064

EDITORIALS 1027

BRIEFING THE RECORD 1067

COMMENTS ON PAPERS 1082

REVIEWS OF BOOKS 1086

A.S.M.E. BOILER CODE 1088

A.S.M.E. NEWS 1089

CONTENTS OF A.S.M.E. TRANSACTIONS . 1112

INDEX TO ADVERTISERS 124

OFFICERS OF THE SOCIETY:

D. ROBERT YARNALL, *President*

K. W. JAPPE, *Treasurer* C. E. DAVIES, *Secretary*

PUBLICATION STAFF:

GEORGE A. STETSON, *Editor* FREDERICK LASK, *Advertising Mgr.*

K. W. CLENDINNING, *Managing Editor*

COMMITTEE ON PUBLICATIONS:

L. N. ROWLEY, JR., *Chairman*

W. A. CARTER J. M. JURAN

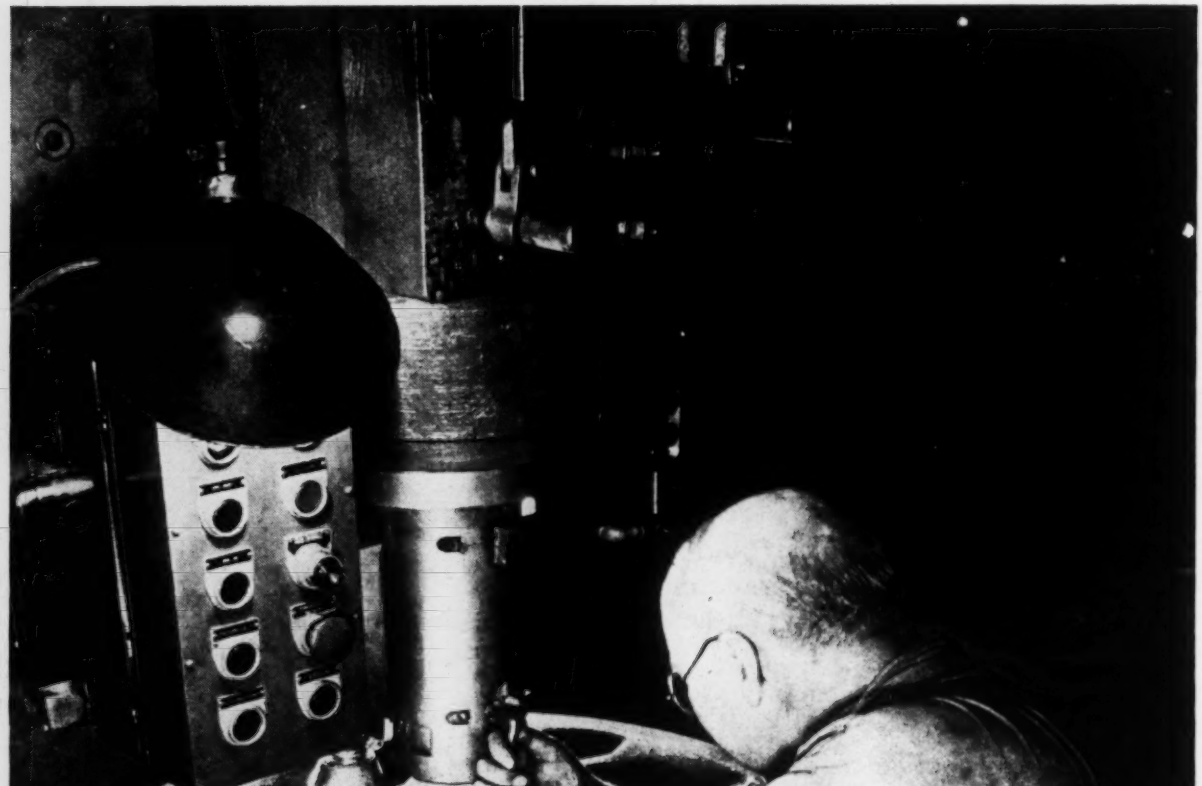
H. L. DRYDEN R. B. SMITH

ADVISORY MEMBERS OF THE COMMITTEE ON PUBLICATIONS:

N. C. EBAUGH, GAINESVILLE, FLA. HUNTER R. HUGHES, JR., DALLAS, TEXAS

Junior Member: JOSEPH M. SEXTON, NEW YORK, N. Y.

Published monthly by The American Society of Mechanical Engineers. Publication office at 20th and Northampton Streets, Easton, Pa. Editorial and Advertising departments at the headquarters of the Society, 29 West Thirty-Ninth Street, New York 18, N. Y. Cable address, "Dynamic," New York. Price 75 cents a copy, $6.00 a year; to members and affiliates, 50 cents a copy, $4.00 a year. Postage outside of the United States of America, $1.50 additional. Changes of address must be received at Society headquarters two weeks before they are to be effective on the mailing list. Please send old as well as new address . . . . By-Law: The Society shall not be responsible for statements or opinions advanced in papers or . . . printed in its publications (B13, Par. 4). . . . Entered as second-class matter at the Post Office at Easton, Pa., under the Act of March 3, 1879. . . . Acceptance for mailing at special rate of postage provided for in section 1103, Act of October 3, 1917, authorized on January 17, 1921. . . . Copyrighted, 1946, by The American Society of Mechanical Engineers. Member of the Audit Bureau of Circulations. Reprints from this publication may be made on condition that full credit be given MECHANICAL ENGINEERING and the author, and that date of publication be stated.



Push-Button Control

(Worker at Michigan City, Ind., freight-car plant of Pullman-Standard Car Manufacturing Co. sets cutting tool in boring bar of new railway-car wheel-boring machine. The push-button panel controls all phases of the machine's automatic cycle of work.)

VOLUME 68
No. 12

MECHANICAL ENGINEERING

DECEMBER
1946

GEORGE A. STETSON, *Editor*

Sanford A. Moss

ABOUT a quarter of a century ago at an Annual Meeting of The American Society of Mechanical Engineers held in the Auditorium of the Engineering Societies Building in New York an argument was in progress on certain thermodynamic relationships. The disputants were failing to convince one another and the audience was becoming bored and confused. Down the right-hand aisle trotted a small nervously energetic man with eye glasses and a pointed beard who seemed intent on entering the controversy. He mounted the stage, seized a piece of chalk, and in simple language pointed out that only in the case of reversible adiabatic processes was the exponent of the expansion curve the ratio of the specific heats. Failure to recognize this fact had been the cause of the argument. The man, as some persons may have guessed, was Sanford A. Moss, who died on November 10, and the incident was typical of him and of his habit of turning squarely to face fundamentals.

Dr. Moss was one of those pioneers in engineering who live to see the devices they develop attain universal recognition and extensive use. With his name the airplane-engine supercharger, conceived during World War I as a means of increasing power output, will forever be associated. For this device he received the Collier Aviation Trophy in 1941, the Sylvanus Albert Reed Award of the Institute of the Aeronautical Sciences, the A.S.M.E. Holley Medal, the Howard N. Potts Medal of The Franklin Institute, and the New England Award of the Engineering Societies of New England. Only by noting the almost universal use of the turbosupercharger as an integral part of the modern aircraft engine can one begin to estimate the importance of this development. One may then attempt an evaluation of the developments in metals to withstand high centrifugal stresses at white hot temperature and inquire what effect these and the turbosupercharger have had on the progress of jet engines and gas turbines.

In addition to the development of the turbosupercharger and other technical achievements, Dr. Moss will be remembered for the militant enthusiasm and energy with which he advanced the cause of the standardization of symbols for scientific and engineering terms. The engineers of Dr. Moss's generation were as individualistic in their choice of symbols as manufacturers and mechanics were with screw threads at the time of the Civil War. Engineering mathematics is a convenient language in which words are replaced by symbols representing concepts and operational procedures. One of the difficulties experienced with mathematics arises from unfamiliarity with the meanings of the symbols used. It is as though one man wrote in English, another in Latin, and the third in Greek, each addressing a fourth whose native tongue was French. Dr. Moss saw that if every writer were to use the same symbol for a given term, engineering students would learn these symbols at college and the comprehension of engineering relationships expressed in mathematical form would be greatly simplified. He labored tirelessly and sometimes aggressively to advance the standardization of terms frequently used, to get persons working in different fields of engineering and science to agree upon the same symbol for concepts common to their fields, and toward the adoption of standard practices in regard to general principles, such as the use of single-letter symbols, the arrangement of subscripts and superscripts, and similar fundamentals. So convinced was he of the importance of his cause that he made such proposals as refusing to accept an A.S.M.E. paper in which the symbols did not conform to A.S.A. Standards. On more than one occasion, with the point of his beard thrust truculently forward and his sharp eyes peering through the lower lenses of his glasses, he threatened to hail the editor before the A.S.M.E. Council for neglect of duty in not changing to the standard form every symbol used in technical papers published by the Society. This wholehearted persistence in the attainment of an objective was one of the traits that endeared Dr. Moss to the editor; and when a gracious retreat from the threat of disciplinary measures softened into an offer that Moss himself would make the changes if papers were sent to him, it was hard to refuse him on the grounds that the proposal was impracticable.

Fixity of purpose in the pursuit of an objective sustained by an unwavering conviction in the righteousness of a cause can arouse irritation and resentment if unrelieved by a sense of humor. With Dr. Moss it was possible to divert some of the keenest barbs of insistence and criticism by a light remark which would bring over his face a look of open-mouthed astonishment, followed by a beatific smile which revealed the essential balance of the man. Respect for his achievements and admiration of his qualities grew, in repeated contacts, into a warm affection for a personality which combined the virtues of mental vigor and human frailty, a bit of the maddening quality of the Devil blended with the evangelical fanaticism of the crusader. He did not scorn to adopt the strategy of a Jesuit, for with him the end frequently justified the means, and what he could not accomplish by direct means he sought to do by indirection, as wit-

ness his recent article, "Alice and the Sluggers." With a correspondent who could stand up to and return his quips and jibes, his letters were anything but samples of business decorum—but they got results.

Others will record and evaluate Dr. Moss's engineering achievements. The purpose here is rather for one whose friendship has persisted over a span of many years to pay tribute to a stimulating and lovable personality.

Future of E.C.P.D.

IN this issue readers will find the report which E. S. Lee, chairman for the last three years of the Engineers' Council for Professional Development, delivered at the fifteenth annual meeting of the Council.

Any appraisal of E.C.P.D. must take into consideration the nature of the organization. E.C.P.D. is not an individual-membership organization. It is a conference of participating bodies, each of which appoints three representatives to the Council. Its committees are necessarily limited in number and in personnel. Consequently, the great body of engineers has little direct contact with E.C.P.D. and under such conditions it is not surprising that there still exist many persons who know little or nothing about E.C.P.D. affairs. During his chairmanship Mr. Lee has addressed many groups and has always met with a favorable response. Engineers, he reports, want to know about E.C.P.D. and have listened attentively to his expositions of it and its program. When intelligently informed about E.C.P.D., engineers become enthusiastic about it. Many features of the work of E.C.P.D. will bear fruit in the future only when the influences it exerts extend more widely to the profession, the educational institutions, and the individual. It is the immediate results of specific projects by which the average engineer will assess the value of E.C.P.D.'s activities and on which he will base his support of E.C.P.D.

The areas in which E.C.P.D. has sought to exert its influence begin with pre-engineering selection and guidance and progress through college and the early years of engineering practice to professional maturity when recognition of the individual engineer's attainments is achieved through corporate membership in an engineering society and registration in his state as a professional engineer.

It is in the first two of these areas, selection and the college, that E.C.P.D. has achieved its most conspicuous success. A practical and scientific approach to student selection, known as the pre-engineering inventory, is being undertaken through the agency of the Carnegie Foundation and the techniques that have been employed are now sufficiently well developed to apply them to achievement tests of men who are in the midst of their college work. This activity is sound, has been fruitful, and reduces human waste in education.

Although the war has temporarily interrupted the program of accrediting curricula in engineering colleges, the work of E.C.P.D. in this field is firmly established. E.C.P.D. lists of accredited curricula have met with almost universal acceptance by persons and institutions who have found it necessary to use them. Extension of the accrediting program to include curricula in technical institutes, begun during the war, promises to be equally valuable and well received as soon as postwar conditions in these schools make possible full-scale prosecution of the project. That the Committee on Engineering Schools has added the achievement tests previously mentioned to its program is gratifying evidence of the fact that it does not propose to limit its work to accreditation.

Unfortunately, achievements in the areas of professional training and professional recognition lag behind those of the Committees on Student Selection and Guidance and on Engineering Schools. The brilliant conception of E.C.P.D. as being concerned with the full cycle of the engineer's life from his precollegiate days to the time when he is accorded recognition as a practicing engineer begins to fade in the areas beyond the college. E.C.P.D. is exerting direct and positive influence through the colleges. It would be natural to assume that the engineering society would be the appropriate channel through which E.C.P.D. would influence young engineers in industry and practice during the period of their professional training and in the important and significant function of recognition of professional maturity. Yet it is through this channel that E.C.P.D.'s influence is least positive and least direct. This is not to say that the societies have entirely neglected their responsibilities or opportunities in these areas. Each society can search its own conscience and justify its own actions. Failure of the societies to achieve a greater degree of success in these areas is not entirely the fault of E.C.P.D. E.C.P.D.'s proper function is to provide materials and mechanisms which the societies can use in this important work, to secure agreement on common practices by which the work can be carried forward and common standards by which recognition of the individual's attainments may be accorded, and to foster unity and professional consciousness. In performing this function E.C.P.D. appears to have succumbed to frustration. Its major tasks still lie ahead of it in this area.

E.C.P.D. had an auspicious start. The purpose and scope laid out by those who were its organizers were sound; they were clearly defined and appealed strongly to men of imagination. E.C.P.D 's leaders have been men of vision. Today E.C.P.D. faces the challenge and opportunity of the postwar world. The need for its services is greater than ever before. It faces the task of recasting its program and of revitalizing its imagination and determination to be of ever-greater service. It is inevitable that E.C.P.D. shall once again examine its objectives, reaffirm its faith in them, bring its programs into sharper focus and state them in clear specific terms, re-establish the natural boundaries of the areas it proposes to cover, and appeal for greater support by the engineering profession and industry. It is inevitable also that to carry on its work it will require greater financial means than it has commanded in the past. But it can command greater financial support only if it has a program of specific projects which will appeal to engineers and to industry as being worth while and possible of accomplishment. E.C.P.D.'s great need appears to some observers to be the adoption of a program of specific projects.

ENGINEERING *in an* ATOMIC ERA

By A. C. KLEIN

ENGINEERING MANAGER, STONE & WEBSTER ENGINEERING CORPORATION, BOSTON, MASS. FELLOW A.S.M.E.

NO one, who has been present at the detonation of an atomic bomb and who has witnessed the awe-inspiring devastation that has followed, can have any doubt that we have just turned over a leaf in the book which records the progress of civilization. The new page might properly be captioned "The Atomic Era." Today, except for a few smudges, it is a clean page on which we may write a history of the attainment of peace and plenty or, upon which, God forbid, we shall write the history of the greatest holocaust that mankind has ever known.

Personally, I believe it will be a record of the attainment of peace and of its manifold benefits, but we cannot lightly proceed on the assumption that this will be so. Eternal vigilance alone will safeguard us against false steps that may set off a new conflagration. The most certain way we can prevent the use of the atomic bomb for military destructiveness is to hasten the improvement in standards of living throughout the world. To that end, the utmost efforts on the part of engineers and industry must be directed to the development of atomic energy for the generation of low-cost electric power so that the peoples of the world may be assured freedom from the causes which have always throughout the history of mankind acted to promote war.

Power is the index of civilization. Adequate power for fertilizers, power for irrigation, and power for farm machinery together spell a prosperous agriculture and freedom from hunger and famine. Adequate power for mines, for factories, and for transportation spell freedom from industrial slavery and low living standards and, incidentally, adquate power for household uses will go far toward insuring domestic peace.

Let us pause to consider where we stand today in our journey along the road which leads to atomic-energy utilization.

PRESENT STATUS OF ATOMIC ENERGY

Status on V-J Day. Between July, 1942, and July, 1945, there was expended in the construction and operation of atomic-bomb facilities a total of over two billion dollars. For this expenditure we accomplished the following results:

(*a*) Development of the uranium industry, beginning with mining the ore and following through to the raw materials necessary for operation of fissionable-material plants.

(*b*) Construction of three major fissionable-material plants at Oak Ridge, Tenn., and Hanford, Wash.

(*c*) Construction of atomic-bomb assembly plant at Los Alamos, New Mexico.

(*d*) Operation of all of these facilities and construction of several atomic bombs at least.

(*e*) The final surrender of Japan and the end of World War II.

Contrary to common belief, scientists were not solely responsible for the development of atomic energy for military uses. Engineers and industry also contributed to a major degree. The true situation was stated very succinctly by Col. K. D. Nichols shortly after V-J Day. Colonel Nichols said, "The public is prone to hail the inventor and the final product and to overlook the engineering and construction that is essential if the idea of the formet is to be translated into the latter. The engineering problems . . . . . were numerous, unique, and staggeringly difficult, the time schedule only slightly short of impossible."

Let us see what the record shows as to the relative magnitude of the work carried on in the fields of engineering and research during this development period. These may be visualized by an analysis of the expenditures made by each group. The figures appear in the statement of expenditures submitted by General Groves in testimony before the McMahon Committee. Three principal processes were enumerated. The amount spent for engineering and construction expressed in millions of dollars is 500 for the diffusion process, 317 for the electromagnetic process, and 302 for the metallurgical process, exclusive of housing. The amount in millions expended on research for those three divisions is 45, 33, and 42, respectively. In other words, if we take the percentage of the whole combined engineering, construction, and research, about 90 per cent was spent for construction and engineering and 10 per cent for research. In addition to construction and engineering, the operating organizations are largely staffed by engineers. Probably the percentage there was also of the order of 90 to 10.

Let no one say that the engineer will not be called on to bear the heaviest burdens in the years to come.

Progress in Past Year. V-J Day found us feverishly operating all completed facilities to their utmost capacity and completing plant construction. During the past year construction has been completed, plants have been operating 24 hours per day and 7 days per week, efficiencies have been improved, costs have been reduced, and plant capacity has been increased. A recently published statement gave present production as several times that on V-J Day. Much of this has come about through continued operation but particularly from lifting the veil of secrecy. This condition has undoubtedly resulted in constantly enlarged stock piles of fissionable material and completed atomic bombs.

Manhattan District Plans for Future. At the present time, the entire operation is under the direction of the U. S. Army, Corps of Engineers, through the specially constituted Manhattan District. Operations may be expected to continue as at present until the creation of a new Atomic Energy Commission.

Additional plans recently announced incorporate a research and development program which will include new facilities and extensions to existing facilities at five locations throughout the country.

ATOMIC ENERGY COMMISSION

During the last year, Congress passed the Atomic Energy Act of 1946, and it is under the provisions of this act, and under the direction of the commission which it creates, that the entire atomic-energy industry must operate. Therefore it is fitting that we examine the make-up of this commission, its powers, and its responsibilities.

Provisions of the act indicate clearly that Congress intended to create the most capable and powerful commission in our Government. The commission will comprise a chairman, four other commissioners, a general manager, and four directors, heading the divisions of research, engineering, production, and military application. The effort which the Congress made to insure a strong capable commission is indicated by the fact that the salary paid the chairman exceeds that of the members of the President's Cabinet. The salaries of the commissioners and the

Presented at the Fall Meeting, Boston, Mass., Sept. 30–Oct. 3, 1946, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

general manager are set at $15,000 per year, which is the same as the Cabinet members' salaries, and the salaries of the directors, $14,000, exceed by a substantial margin the salaries paid members and heads of most other independent commissions. It is to be hoped that the President will recognize the challenge and will appoint the best commission possible. To guard against the appointment of any misfits, the bill provides that the initial appointees shall hold office for a period of two years only, and that new appointments shall be made at that time for the normal five-year tenure of office.

The act also provides for two advisory committees, a Military Liaison Committee, appointed by the Secretaries of War and Navy, and a General Advisory Committee, consisting of nine members appointed by the President from civilian life. The function of the latter committee is to advise the commission on scientific and technical matters of a nonmilitary nature.

The Atomic Energy Commission will inherit the entire atomic empire, including plants, finished and semifinished bombs, and all other property now held by any government department or agency which pertains to nuclear or atomic processes. It will have sole power over the entire industry, starting with uranium ore in the ground, up to and including finished products containing and produced from uranium. It will also take over all patents, contracts, and secret information and, subject to the President's direction, it will have sole power of disseminating information and distributing uranium products, including bombs.

If, for instance, one of our industrial concerns or one or a group, of our electric utilities wishes to develop processes involving atomic-energy utilization, permission must first be obtained from the commission to do so. The commission may then allot sufficient stocks of uranium or fissionable material to the project either free or on terms it fixes. It may also bear part of the cost by making grants in aid, or it may even finance the entire development.

FUTURE OF ATOMIC ENERGY

Military Aspects. No discussion of atomic energy can overlook its military aspects. We as engineers are vitally interested in seeing that the international situation is cleared up at the earliest possible moment. To the extent that our plants must operate for military purposes, just to that extent are they hindered from producing material for peacetime purposes.

No one who has gone through the engineering and development work which led to production of bombs can do other than conclude that it will be a decade before any other nation can vie with us in atomic-bomb production. I venture to predict that our research program, if implemented with proper engineering development, will keep us in the forefront for a generation at least. During that time it behooves us to settle the international situation so that it will never again arise to threaten us.

We have the bombs. We have the production facilities. We have the engineering know-how. We have the industrial plant to implement that know-how. It would be the height of folly for us to throw away the advantages which this position gives us, except on our own terms.

Nearly a year ago, in a paper delivered before the Boston Section of this Society, I outlined a program whereby we might permit the Security Council of the United Nations to direct us to use our bombs for punitive measures. At that time none of us could visualize the studied nonco-operation of the Soviet Union. It seems to me that the time has now come when we must go forward with a plan for the control of the atomic bomb based on associating ourselves with those nations which are favorably disposed to our plan. Let the Russians stay on the outside if they do not care to come in. When and as they do care to come in, we can entertain their application.

It may be claimed, in opposition to such a plan, that we may be subjected to another Pearl Harbor at the hands of some unfriendly nation not a member of the atomic-energy group. I see little danger of such a contingency as long as we have a large stock pile of bombs. Let us suppose some nation was fanatical enough to make a sneak attack on some of our coastal or industrial cities. Suppose they badly damaged New York, Pittsburgh, Philadelphia, and Boston, and paralyzed our industrial production at those points. Frightful as such a contingency would be to contemplate, it would not protect the aggressor nation against rapid and highly destructive retaliation. We would not be foolish enough to have bombs located at vulnerable points. Rather, they would be hidden in the Berkshires, the Catskills, the mountains of the Pacific Coast, and in carefully selected hideouts in our rural areas. From these points skilled operators could dispatch them with unerring aim and completely paralyze the industry of the aggressor nation. I do not look for such an eventuality, but I do contend that the fear of retaliation would prevent any nation from attacking another one which had an adequate stock pile of atomic missiles, in just the same way that fear of retaliation banned the use of poison gas and disease germs during the late war.

Peacetime Application. The peacetime application in which we are primarily interested is that of atomic power. How soon will it come? How extensive will its application be, and what will be its effect on our power bills?

In my opinion, the task of producing atomic energy and of converting it into electricity or steam is a task equal in magnitude to that of constructing one of the major atomic-bomb-material plants, and the time that will be required to do so will be of the order of from three to five years. Moreover, after the project is solved from an engineering standpoint, it will not necessarily be economically sound. Only continued operation of atomic-energy plants for a period of many years, and the improvement in design and operating techniques that will come through such operation, can result in what we commonly term "cheap" atomic-power energy. I would say that it would be at least ten years before atomic energy will have any effect upon electricity costs.

Now, what will be the effect of the economic development of atomic piles upon our industries? The first question is: To what extent will it supplant coal and other fuels? The answer is, it will supplant them to a limited extent only, because there is room enough in the growth of our demand for power to absorb all of the uranium that will be produced and at the same time to keep our coal mines, our oil wells, and our hydroelectric plants operating at normal capacity. The effect of atomic energy will be minor compared to the fluctuations in fuel demand that accompany changes in our business cycles.

Next, what industries can generate atomic energy to best advantage? The answer is that only the very largest consumers of power will be able to consider operating their own atomic-energy plants. The atomic-energy unit is inherently a large-scale device. Operation is accompanied by continuous emission of radioactivity. Operators and property must be protected by walls of concrete, usually about six feet thick. Chemical-separation facilities must be provided so that the active material may be reprocessed periodically to remove the fission products which after a time slow down or stop the operation. All of these are factors which will preclude the development of atomic energy on any small scale.

I would anticipate that the first commercial plants to be built would be of the order of hundreds of thousands, perhaps even up to a million kilowatts in size, that they would be connected to an interconnected network of several of our largest public-utility systems, and that industry and the public in general would be affected very little by their operation, except as an ultimately lower cost of producing electricity will make it

possible to lower electric-power bills. At a later time, the electrochemical industries will undoubtedly have their own atomic-power plants but, in the main, our industries will continue for a long time to receive their atomic power over the lines of their electric-power utilities.

Another important peacetime use of atomic energy is in the production of radioactive materials for medical and biological purposes. This work is now under way on a semicommercial basis. No outstanding difficulties or problems remain to be solved. In fact, the Manhattan District has announced the production and distribution of several radioactive elements, and there is no reason why production should not continue on an increasing scale as the need for specific materials is indicated.

Another important outgrowth of the atomic-bomb work is in the field that has been opened up for the separation of isotopes. Isotopes are forms of an element which differ principally in their weight. They do, however, differ very slightly in other respects, and it is quite probable that their separation and study may lead to important developments in chemistry and metallurgy. Isotope study is a practically untouched field and much work lies ahead for scientists and engineers in it.

Space does not permit the enumeration of the many collateral advances in engineering which have resulted from atomic-bomb work. Suffice it to say that they have had and will have a profound effect on the future of engineering and industry.

OUR RESPONSIBILITIES IN THE ATOMIC ERA

With this vista of the atomic era before us, it becomes highly important that we consider the responsibilities that face engineers, and the steps that should be taken to discharge them. Two facts are evident:

(*a*) The engineering profession will be called upon to play a major part in the development of the atomic era.

(*b*) It must work with the Atomic Energy Commission and under rules laid down by it.

Such being the case, we have a vital interest in the make-up of the Commission and in collaborating in the formation of its rules of procedure. We as an organization, representing the mechanical-engineering profession, should make our recommendations known to the President and later to the commission, and we should direct those recommendations toward the appointment of capable experienced commissioners and directors.

In October, 1945, a number of us, who had been involved in the atomic project, studied the several atomic-energy bills which were before Congress and decided the McMahon Bill was to be preferred to all others. We considered the possibility of appearing before the committee to make our views known, but were deterred because of the secrecy agreements we had signed. Early this year, however, Mr. J. R. Lotz, chairman of the board of directors of Stone & Webster Engineering Corporation, received an invitation to testify before the McMahon Committee and in response to it, Mr. Lotz, Mr. MacKrell, of our Washington office, and I prepared a statement to support our belief that the Bill should be amended to provide strong engineering representation. That statement was presented to the committee on February 13, 1946, together with considerable additional testimony during the cross-examination that followed. At the end of the session, Chairman McMahon told us he would have the Bill amended to provide for a Division of Engineering, as we had recommended. However, we felt we should have additional weight of engineering support so when copies of the testimony were available, they were sent to a number of technical magazines, some of which supported the idea in their editorial columns. We also enlisted the support of the Engineers Joint Council, which is composed of the presidents of the five principal engineering societies. That request resulted in a telegram to Senator McMahon, supporting the recommendation and amplifying it. The Society of Professional Engineers, in a telegram signed by its secretary, also endorsed the recommendation. As a result, we have an act providing for a Division of Engineering.

A short time ago, I addressed a letter to the President in which I recommended that he appoint as one of the commissioners, and preferably as chairman of the commission, an experienced engineer who had an administrative background. The assistance and support of the Engineers Joint Council has been enlisted for that recommendation. The National Society of Professional Engineers has endorsed this recommendation and I have just been informed that the Engineers Joint Council did likewise at its meeting on September 26. This cannot fail to impress the Administration with the unity of the engineering profession, and its awareness of responsibilities in this field.

Other opportunities are ahead for us to insure the adequate engineering balance that the commission must have if it is to function as Congress intended and as the American people expect it to function.

CONCLUSION

The major question before us is how the engineering profession can assume its part in shouldering the responsibilities of the atomic era. I have tried to point out that engineers must accept these responsibilities.

I should like to make a few recommendations along these lines. The first is that this Society should organize as one of its professional divisions, a Division of Atomistics. Such a division would prove the rallying post for the thousands of our members who contributed to the atomic-bomb development and who still maintain a keen interest in atomic engineering. If we fail to organize such a division, it will inevitably result in the formation of an atomic-engineering society. We have too many engineering societies now; many of them have been formed because of the lethargy of the Founder Societies in recognizing the growing importance of component elements of engineering. Let us not make the same mistake again but let us actively lay plans so that the formation of such a professional division can be officially approved without delay.

Pending the formation of such a division, much constructive work can be done and should be done. We should study the Atomic Energy Act of 1946, and take advantage of the opportunities it offers for constructive service in the formation of the Atomic Energy Commission. Undoubtedly, an engineer will head the commission's Division of Engineering, but there is no reason why all of the divisions, except Military Application, could not to advantage also be headed by engineers. Another opportunity we should not overlook is in connection with the President's appointment of the General Advisory Committee. This is to be composed of nine members appointed by the President from civil life. At least five of these should be engineers, one appointed from each of the five societies which compose the Engineers Joint Council. This would be a cross section of the entire engineering profession and would insure the most efficient co-operation between the societies and the Atomic Energy Commission.

This is no job for individuals. It is a job to be undertaken by this and its fellow engineering societies. It is a job to be well and carefully planned and to be prosecuted with all the organized might of the engineering profession. If we obtain a competent, well-balanced commission, our future work of implementing the problems of the atomic era can be handled with efficiency and dispatch. Let us resolve to do exactly that, so that the atomic era may be one, not of the fratricidal destruction that is so generally predicted, but of the extension of peace, plenty, and high living standards to all the peoples of the world

POWER—*Where Do We Go From Here?*

By HARRY A. WINNE

VICE-PRESIDENT, GENERAL ELECTRIC COMPANY, SCHENECTADY, N. Y. MEMBER A.S.M.E.

THE history of the development and use of power in the United States in the last 45 years is both fascinating and startling. At the turn of the century, electric utilities produced in 1 year only about 1 billion kwhr. Fifteen years later, production reached 16 billion. In another 15 years it had reached almost 100 billion, and by 1945 the total was over 220 billion kwhr. Roughly $^2/_3$ of this power was produced from fuel and $^1/_3$ from hydropower.

In this discussion of power, only power generated from fuel will be discussed, since that constitutes such a large part of our total usage, and primarily power generated by public utilities.

Forty-five years ago the average coal consumption was about 6 lb per kwhr, with only the best units getting as low as 3 lb. In 1920 the average was about 3 lb and by 1925 this had been forced down to a little over 2 lb. At about that time a real step forward was made by the introduction of much higher steam pressures.

POWER HISTORY MADE IN BOSTON

At this point, it is fitting to pay a well-deserved tribute to Mr. Irving Moultrop who was then assistant superintendent of the Construction Bureau of the Edison Electric Illuminating Company of Boston. Mr. Moultrop was responsible for ordering the first turbine to be designed for 1200 psi initial steam pressure. At a time when the average pressure used in central stations was 250 psi, and the maximum 350 psi, it took real courage to make a 1200-psi installation, but this is just what Mr. Moultrop did. This unit went into operation as a 2400-kw 1000-psi topping turbine on December 5, 1925, and after about a year's successful operation the pressure was increased to 1200 psi and the output to 3150 kw.

The installation of this history-making unit is a fine example of the co-operation and mutual understanding which has existed between the utilities, the electrical-machinery builders, and the boiler manufacturers through the years. Mr. Moultrop and Mr. Oscar Junggren, then in charge of turbine design for our company, had long been intrigued with the idea of getting increased efficiency by going to much higher pressures, and this unit represented the culmination of their thinking.

At that time, all the European builders said such a unit would require a solid casing. But Mr. Junggren, with Mr. Moultrop's acquiescence, went ahead with a split-casing design and it worked.

The construction of this unit at 3600 rpm and for 360 psi back pressure resulted in a rotor so small that the designers themselves, with the exception of Mr. Junggren, had grave misgivings whether such a "watch-charm" rotor, as they termed it, could ever develop 3000 kw. Subsequent experience, of course, has shown that we can get much more than that out of a rotor physically no larger.

ONLY THE BEGINNING OF IMPROVEMENTS

Following Mr. Moultrop's lead, the drive toward higher pressures and temperatures took the country by storm, so rapidly and so effectively that in the ensuing 20 years the coal consumption of the best plants has decreased almost two thirds, to about $^3/_4$ lb. In fact, the average coal consumption of the country is now only about $1^1/_4$ lb per kwhr.

As illustrative of the rate of progress, it may be of interest to review some of the other "firsts" in pressure and temperature. The first unit built by the author's company for 750 F, which today is considered a low temperature, was a 77,000-kw machine supplied to the Commonwealth Edison Company in 1926. Not until 7 years later, 1933, did we venture into the unexplored region of 825 F, with a 35,000-kw unit for the Potomac Electric Power Company. This period marked the first use of alloying elements in steels for higher temperature. Once this advance had been made, the trend toward higher temperatures got into full stride, and 3 years later we constructed a 900 F, 15,000-kw unit. After only 2 more years, in 1938, we furnished a 950 F 50,000-kw unit to the Public Service Electric and Gas Company of New Jersey. Today, we are designing and building a 1050 F 100,000-kw unit which will be discussed later.

The highest-pressure unit which we have built to date is the 2300-psi Twin Branch installation of the Indiana and Michigan Electric Company (American Gas and Electric System).

A large part of the gain which we have made since the conclusion of the first world war may be attributed to the courage and vision of purchasers—the utilities—and their willingness to co-operate with us as turbine builders in taking steps well ahead of past practice. Commendation is also due the boiler manufacturers, who have had their own problems in providing steam at today's high pressures and temperatures.

An analysis of the 30 to 40 per cent reduction in fuel consumption which has been made in that quarter century, shows that it may be divided approximately as follows:

1 By increasing pressures from 200 to 1200 psi, we have saved about 10 per cent.

2 By increasing initial temperatures from 600 to 950 F, we have saved 10 to 14 per cent.

3 By adopting, almost universally, multistage regenerative feedwater heating, we have saved 6 to 8 per cent.

4 By making use occasionally of the reheat cycle, we have saved 2 to 6 per cent.

EMMET MERCURY-VAPOR PROCESS

Let us turn now to another of the developments in recent history. Before the first world war, W. LeR. Emmet proposed to the engineering world the "Emmet mercury-vapor process," with which most readers are familiar. It was Mr. Emmet's early contention that by the use of two working fluids in the power-plant cycle, the one, mercury, supplying its leftover heat to the other, water, we could improve appreciably on power-plant thermal efficiencies. Initial experimental installations at the Dutch Point plant of the Hartford Electric Light Company proved Mr. Emmet's contentions to be correct. A later installation at the South Meadows plant of the same company yielded a plant heat rate of slightly higher than 10,000 Btu per kwhr, a record which has only recently been broken in steam plants. The average heat consumption in the United States during 1927 and 1928, when this unit first operated, was over 23,000 Btu per kwhr and even the best stations at that time had a heat consumption of about 12,500 Btu per kwhr.

Contributed by the Power Division and presented at the Fall Meeting, Boston, Mass., Sept. 30–Oct. 3, 1946, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

The South Meadows installation was outstandingly successful, its only major maintenance operation having been the retubing of the boiler in 1931; this despite the fact that its operating temperature was 884 F.

Two other mercury plants are now operating. One of these is at the Kearny plant of the Public Service Electric and Gas Company of New Jersey, where a mercury turbine produces 21,000 kw, and steam for about 30,000 kw additional, with an over-all heat consumption of about 9200 Btu per kwhr. The other is in our Schenectady works, producing 10,000 to 12,000 kw from the mercury turbine.

Of course, there have been troubles with the mercury-vapor process. One of these was in getting the mercury to wet the boiler tubes. This has been overcome by a simple chemical treatment. That we have not lost faith in the mercury plant is evidenced by the fact that we are today building, for installation in our Pittsfield, Mass., works a mercury plant having a 7500-kw mercury turbine, which will be capable of supplying from the mercury condenser over 120,000 lb of process steam per hr.

PRESENT HIGH PRESSURE - HIGH TEMPERATURE STEAM TREND

And now—where are we today? We have, as already indicated, pushed fuel consumptions down, and down, and further down. We have arrived at the period of high pressures and high temperatures. Proof that we have arrived is easily found in the recently adopted A.S.M.E.-A.I.E.E. preferred standard steam conditions for turbines. Under these standard conditions, all units larger than 20,000 kw are specified as having 850 psi 900 F initial conditions, with the 40,000- and 60,000-kw units having an alternative of 1250 psi 950 F. Thus, the high pressure - high temperature trend has been officially recognized.

Let us consider a few notable units. The Indiana and Michigan Electric Company, Twin Branch unit, which has been in operation for several years, has already been mentioned. This is rated 76,500 kw, designed for initial steam pressure of 2300 psi, 940 F, with reheat to 900 F. This unit has a heat rate of approximately 10,000 Btu per kwhr.

Another notable design is being manufactured for the Public Service Electric and Gas Company of New Jersey, rated 100,000 kw, 1250 psi, 1000 F. This will be a tandem-compound unit, 3600 rpm, with double-flow low-pressure turbine.

Another unit for the Sewaren Plant of the same company is being designed for 100,000 kw, 1500 psi, 1050 F. This also is tandem-compound, but with triple-flow low-pressure turbine.

For the Pomeroy station of the Ohio Power Company (American Gas and Electric System), we are designing a 145,000-kw 2000-psi unit with initial temperature of 1050 F and reheat to 1000 F. This will be a cross-compound design, with double-flow exhaust and gives promise of being the highest-efficiency installation in the country.

One of the developments of recent years, which has enabled us to design for the high pressures and temperatures just mentioned, is the large 3600-rpm turbine. Generally speaking these units have shell and rotor diameters only one half those of the older-style 1800-rpm machines, thus making shell-bolting problems and expansion problems, as well as other design details considerably easier.

The trend of our business to higher pressures and temperatures parallels the trend from 1800 to 3600 rpm. For example, if we consider two successive 4-year periods (1940 to 1943 and 1944 to 1947, respectively), we notice that in terms of our total utility-turbine business, the percentage of kilowatts produced for 3600 rpm has increased from 58 to 68 per cent. At the same time, the percentage of kilowatts on order for 850 psi and higher pressures has increased from 72 to 81. The percentage of kilowatts for 800 F and higher has increased from 85 to 97. Note that almost our entire production, namely, 97 per cent is for temperatures of 800 F and higher. Our total turbine-years of experience with machines at temperatures of 900 F and over is now in the neighborhood of 500.

WHAT IS THE NEXT OBJECTIVE?

Now, where are we going? Undoubtedly, the steam plant will see its greatest advances in future progress to higher and higher pressures and temperatures, to better cycles, and to better co-ordination of power and process requirements, the beginnings of which we have seen in the last decade. It has not always been easy; in fact, it may be said truthfully that, in the past, it has always been difficult to produce machines for pressures and temperatures beyond all previous experience. It will not be easy in the future, but the author is sure we shall do it. We are urging our metallurgists to find materials suitable for continuous operation at 1200 F and higher; we are asking our designers to produce machines to operate at these temperatures and still have the almost perfect reliability demanded by all utilities.

Aerodynamics will yield improved turbine efficiencies; new variable-angle stage designs will make their contributions to smoother steam flow and higher efficiencies. Better knowledge and analysis of exhaust-blading design will extend the range of capacities for which the various frame sizes can be built. However, it seems apparent that any major reduction in fuel consumption in the future must come through improvements or changes in the heat cycle, as the efficiencies of the individual operating units, such as turbines and boilers, are already at a fairly high level.

It is the author's belief that we shall see additional mercury installations. It is true that there is not today the difference in heat consumption between the mercury and the steam plant that there was when the first mercury installation was made. As always happens, the target has moved ahead and reduced the gap. But we must not forget the possibility, as we gain experience, of operating mercury above today's 950 F and the consequent gain in efficiency which would result.

Developments in the mercury boiler will permit reduced investment in mercury, and the first cost of the whole installation can undoubtedly be lowered considerably. Its already high availability and reliability can unquestionably be improved. Mr. Emmet's dreams may yet materialize.

LOOKING AHEAD

Gas Turbine. In attempting to look into the future, we must not overlook that comparative newcomer to the field of power, the gas-turbine. No doubt the reader is familar to some extent with the status of the gas turbine as an aircraft power plant. The jet-propelled plane is the record breaker among aircraft. The airplane powered by a gas turbine driving a propeller, with jet as an auxiliary, is now flying and will become of increasing importance to commercial as well as to military aviation.

Of more interest, however, to the power industry is the stationary gas turbine. Several units are now in operation in various parts of the world. Some of these units have modest thermal efficiencies, i.e., some 15 to 20 per cent; others have efficiencies approaching those of modern steam plants, i.e., in the 30 per cent and higher range. More remarkable, perhaps, than their efficiencies is the fact that they do produce power. It is well known that for many years no one was able to build a gas turbine which produced any net power. Today, manufacturers are willing to accept commissions to build power-producing gas turbines in sizes suitable for utility use. Although certainly such an application is considered to be not unreasonable, it is generally conceded that, because of the small

size, lightweight, simplicity, and versatility of this unit, the most attractive applications will be in fields where these virtues are in greatest demand—the airplane, the ship, and the locomotive.

The gas turbine will profit greatly in the next decade from the indubitable progress in metallurgy and aerodynamics which lies before us. Perhaps the eventual power unit will resemble only slightly our present version; it may be a completely closed cycle, it may be a semiclosed cycle, or, in fact, it may turn out to be the simple open-cycle unit, having modest efficiency and no water consumption. Only a prophet can forecast which type will be most in demand by users. Even an engineer, however, can prophesy that this modern internal-combustion turbine will find many and broad fields of usefulness in all technical fields where power is required.

It will gravitate to the most desirable applications; use at the end of long transmission lines; use as a low-cost stand-by unit; use in arid areas; to drive locomotives; to propel supersonic aircraft; to drive ocean-going cargo vessels, and perhaps even naval vessels. It will be built in all sorts of combinations, high-efficiency units of complex cycle and extensive heating surface for high-fuel-cost regions, and simple modest-efficiency plants having only turbine, compressor, and combustion chamber, for low-fuel-cost applications. It will be built to run on natural gas, high-grade and low-grade fuel oils, and eventually, we believe, on producer gas or pulverized coal.

Atomic Power. Now, as we look into the future we encounter a new, but very much talked of, possible source of power. Reference of course is to nuclear, or as it is more generally termed, atomic energy. Whether, and when, this will become an important factor in power generation, only time can tell.

Atomic energy is essentially a source of heat. We can foresee no way of converting it directly into usable electrical power in significant quantities. So we may look for the atomic power plant of the future to consist of the nuclear reactor, or so-called "pile," in which heat will be generated by fission, and transferred through suitable means, probably with an intermediate transfer, to some more or less conventional power-generating unit, such as a steam turbine, a gas turbine, or a unit utilizing the vapor of mercury or some other substance. As many readers know, such a plant is already being engineered at the Clinton Laboratories, Oak Ridge, Tenn. But this is simply a pilot plant, a developmental installation, really practically a laboratory experiment. Many, many technical problems remain to be solved, but the author feels sure they can be and will be solved in the course of time.

One has only to look at the years it has taken to bring the mercury plant to its present state of development, or the gas turbine, to realize that a long road of development lies ahead.

Beyond the technical questions there are those of economics and here the answer is still less certain. There are still far too many unknown factors in the economic equation.

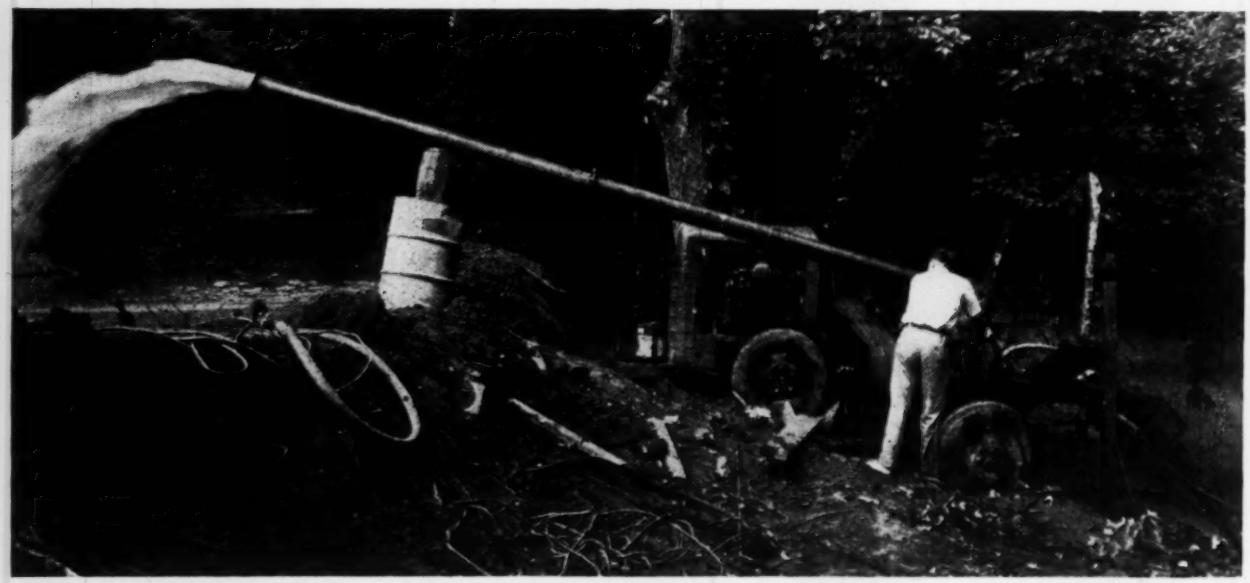
Personally, the author believes that in the course of time, production of electrical power from atomic energy will become an important factor. But in his estimation, that time is considerably more than 10 years away, quite possibly 2 or 3 decades. The introduction of atomic power into our economy will it is believed be very gradual and not at all upsetting to our present utility industry. It is felt that atomic energy will supplement and complement our present power sources—not replace them.

CONCLUSION

So, as we look ahead, we see plenty of enticing possibilities on the horizon—higher steam pressures and temperatures; mercury or other binary cycles; gas turbines; atomic energy. Surely these present great challenges to the engineers responsible for building and using power-generating equipment. The author is sure these challenges will be met, as they have been in the past, with untold resulting benefits to all humanity.

ACKNOWLEDGMENT

The author wishes to acknowledge his indebtedness to J. Kenneth Salisbury, turbine engineering division, of the General Electric Company, for assistance in the preparation of this paper.



MAKING SAND FOR BURLINGTON, N. C., AIRPORT

(Pointing like a huge field gun, the outlet pipe of a Diesel-driven sand pump is busy throwing sand from Alamance Creek, near Burlington, N. C., for the Thompson-Arthur Construction Company. Water is drained from the reservoir into which the pump empties and the sand is removed by shovel and truck for sand-asphalt paving of the sizable Burlington Airport being constructed.)

WOOD-TO-METAL ADHESIVES

By THOMAS D. PERRY

DEVELOPMENT ENGINEER, RESINOUS PRODUCTS & CHEMICAL COMPANY, PHILADELPHIA, PA. MEMBER A.S.M.E.

THE conventional wood glues, which have been utilized in plywood operations for many years, are rapidly being superseded by the newer resin adhesives that have become commercially important in the last decade. These resin adhesives (1)[1] for woodwork include the phenolic, resorcinol, urea, and melamine types; both for hot-press and room-temperature operations.

A similar evolution in wood-to-metal adhesives is of much more recent origin, in fact it is just beginning to gain momentum in the manufacturing industries. Casein-latex combinations (2) have been used for some years in several types of plymetal constructions and have given satisfactory results. However, both casein and latex have their limitations, chiefly in ultimate durability under severe exposures. They have been hardened at room temperature, and consequently the time-economy of the hot-pressed resins in plywood fabrication have not been enjoyed.

The three outstanding advantages developed in hot-pressed resin adhesives for plywood are (*a*) extreme durability, (*b*) major reductions in time, equipment, and space, and (*c*) slight compression (5 per cent or less when wood is heated) to equalize uneven thickness together with partial resin penetration into the wood. These advantages can now be incorporated in wood-to-metal gluing, with equal benefits to the industry, and thus open up many new fields of utilization.

SUMMARY OF METAL-TO-WOOD COMBINATIONS

Before discussing how such metal-to-wood bonds are made, it may be well to list some of the more important practical applications so that the objectives may be kept clearly in mind.

The layers of metal and sheets of veneer each contribute substantially to the qualities of the combined plymetal, a general trade term applied to this product. This paper will deal largely with plymetal constructions in large sheets or areas, since this is the field in which the metal-to-wood adhesives are outstanding and in which most of the developments have occurred. The same technique is also applicable to other types of metal-to-wood gluing and some typical examples will be cited.

The metals are characterized by high density, surface hardness, fireproofness, and high strength, although they are heavy and, in thin sheets, lack stiffness. On the other hand, wood is light in weight, has good insulating values for heat and sound, is moderate in cost, with excellent stiffness factors, and at all stages is easy to work. Plymetal combines the good qualities of both and compensates for the less desirable qualities of each.

A brief outline of the products in which plymetal has already played an important part is impressive, and a more detailed description of these products will be found toward the end of this paper.

1 The transportation industries, highway and railroad, have used plymetal for years in locations where the metal face resists wear and abrasion and adds strength, while the plywood backing contributes stiffness and keeps down the weight. Illustrations are floors, sides, and operator cabs for trucks; walls and roofs for buses; many parts for lightweight streamline railroad cars. Steel-plywood constructions have been conspicuous in this field.

2 In aircraft, strength/weight ratios are of maximum importance. Sandwich constructions (3, 4, 5, 6, 7, 8) with metal surfaces and low-density interiors have developed remarkable stiffness and have been a great boon to aircraft designers in floors, cockpits, bulkheads, etc. Aluminum alloy-plywood constructions have proved their worth in this field.

3 Industrial buildings, such as moderate-sized warehouses, yard offices, fire-protection-equipment shelters, switch and signal towers, crane cabs, and guard booths have all proved that plymetal combines safety from fire, reasonable insulation for warmth, sturdiness, and portability. Both steel and aluminum have been used in such plymetal combinations and several companies are vigorously developing this structural field.

4 Plymetal has proved to be unsurpassed for interior enclosures in zoned areas of cities where a fireproof or noncombustible barrier is required by code, i.e., elevator enclosures and cabs, stair wells, office partitions, conveyer enclosures, and the like. Steel sheets have been used as either outer or inner layers in these projects.

5 An interesting table-top construction has been developed for office desks, bank counters, and smoking stands, where an inserted sheet of aluminum is provided to absorb and distribute the heat from lighted cigarettes so that the outer wood surface is in no way disfigured.

6 Kitchen equipment, table tops, drainboards, kitchen-cabinet tops and counters, refrigerator cabinets and the like, are much improved by metal surfaces for cleanliness and wear, backed by a lightweight plywood for stiffness and heat insulation. Both steel and aluminum are so employed.

7 Many types of hospital equipment benefit by the same plymetal constructions as noted for kitchen equipment and are easily kept surgically clean.

8 An interesting type of military development in plymetal was the powder case or chest. This consists of a lightweight case as a single unit, with a metal interior and wood exterior, displacing a much heavier two-unit item with a metal inner can and an outer wooden crate.

9 Tool handles, while not a plywood product, are of wood normally attached to steel or iron parts by rivets, bolts, or screws. An ingenious adaptation of wood-to-metal bonding results in rivetless handles.

These are only a few of the possible applications of plymetal, some of which were born of the war effort. In the postwar years many new combination developments are sure to appear.

FUNDAMENTALS OF ADHESION

The theories underlying the principles of adhesion are not as yet well understood, although the advent of resin adhesives during the last decade has emphasized the need of more fundamental knowledge in this direction. An excellent summary of the situation, prepared by the U. S. Bureau of Standards, has been made available recently (9) and contains an extensive bibliography on all phases of the subject for those who wish to investigate further.

[1] Numbers in parentheses refer to the Bibliography at the end of the paper.

Contributed by the Wood Industries Division and presented at the Annual Meeting, New York, N. Y., December 2-6, 1946, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

In general, two principal types of adhesion have been recognized; viz., "mechanical," between porous surfaces, such as wood, paper, cloth, etc.; "specific," between smooth dense surfaces, such as metals, compreg, etc.

More recent investigators conclude that mechanical adhesion or the interlocking of the hardenable prongs of adhesive in the voids of the wood structure is not as important as it was formerly considered. The more modern view is that polar or electrostatic effects, together with chemical and molecular combinations, are chiefly responsible for strong bonds. This is true both in porous or penetrable surfaces as well as in dense and relatively nonpenetrable surfaces.

However, the terms mechanical and specific adhesion as just defined can be helpful in visualizing and discussing the types of adhesive bonds that are proving of substantial interest to industry at the present time.

It is well known that when gluing a harder wood to a softer wood the adhesive tends to penetrate more rapidly into the less dense layer, and that the glue penetration into the more dense layer may be found inadequate. This is particularly noticeable in metal-to-wood joints, where the metal is relatively nonpenetrable. Hence adhesives for such combination joints must be characterized both by a high degree of specific adhesiveness for the benefit of the metal and have, as well, a capacity for mechanical adhesion on the wood side. Much research has been devoted to developing such a duplex type of adhesive.

ORIGIN OF METAL-TO-WOOD GLUING

The foundations of plymetal were laid some 20 or more years ago, when casein-latex (2) mixtures were favored adhesives for wood and metal combinations. It required the impetus of the war effort to carry this project forward. However, the approach was different; instead of endeavoring to improve the casein-latex combinations, the principal research was directed toward metal-to-metal adhesives, in the synthetic-resin field. With a background of experience in metal-to-metal bonds, it was felt that metal-to-wood bonds would be a logical outgrowth.

Metal-to-Metal Bonding. The use of thin aluminum for wing and fuselage covering was imperative in certain types of aircraft; riveting was not very effective on thin material and resulted in a rough surface that impeded flight; while welding in thin metal was difficult and developed concentrated stresses that were highly objectionable. The demand was urgent for a metal-to-metal adhesive and, like many other seemingly impossible problems, it was solved by industrial research.

Quite a number of such metal-to-metal adhesives appeared, among them Redux (10), Cycleweld, Cordo (11), Reanite, Bostik, Araldit (12), to mention a few. They differ considerably in ingredients and technique among themselves, but all require heat and pressure for a durable bond and are largely thermosetting in character. Since Redux is the one with which the author is most familiar, it will be taken as typical of this group and briefly explained. While Redux originated in England,[2] the author's company has undertaken its further development in the United States. It is a synthetic-resin adhesive supplied in liquid form, with the extreme durability, when properly cured, of the phenolic adhesives used in plywood. For metal-bonding it is used with a dry powder, a combination that produces strength and durability in metal-to-metal joints. Its cure is accomplished by simultaneous heat and pressure. An important requirement in all metal-bonding is the scrupulous degreasing, and a slight roughening of the metal surfaces is frequently desirable.

Adaptation of Metal-to-Metal Experience. Properly designed and cured metal-to-metal joints will withstand shear stresses of the order of 4000 to 5000 psi, a far higher value than can be obtained in any common species of wood. Hard (sugar) maple is credited (13) with an average shearing strength, parallel to the grain, of 2300 psi; birch 2020 psi; red gum 1610 psi; Douglas fir 1140 psi; and poplar 1100 psi. Hence the shear-strength objective, in metal-to-wood bonding, should be of the order indicated by these averages, since any surplus appreciably above these limits would have little practical value. While Redux or its equivalent could be used for metal-to-wood joints, a simpler and less costly procedure would be desirable, from an economic industrial viewpoint. One of the obvious steps in this direction is to use the metal-adhesive technique only on the metal side, and employ a standard resin adhesive of compatible character on the wood side of the joint. Other methods of meeting this situation will be outlined.

METHODS OF METAL-TO-WOOD GLUING

There are several procedures for metal-to-wood bonding, as follows:

1 Metal adhesives on one with wood adhesives on the other mating surface, single-stage process.
2 Adhesive-coated metal surfaces, two-stage process.
3 Film adhesive, interlaid in joint, especially for plywood.
4 Nonplywood applications, as solid wood to metal.

These are not alternate procedures, and the choice will depend on design, on construction of the product with equipment available, as well as on strength, durability, and cost limitations required for the product.

Metal Adhesives and Wood Adhesives on Mating Surfaces. This first group employs a standard metal-to-metal adhesive on the metal side of the joint and a compatible wood adhesive on the mating side, which in the case of Redux would be a phenol-formaldehyde or resorcinol-formaldehyde-resin adhesive. The procedure is as follows:

1 The metal surface is thoroughly cleaned by acid-etching, solvent-degreasing, or scouring with an abrasive soap. The surface must be clean enough to carry a continuous water film without break.

2 The metal surface is slightly roughened to remove any oversmooth surface that would interfere with adhesion.

3 The liquid is spread on the appropriate metal area, followed immediately by an application of as much powder as will be retained by the liquid.

4 The surplus solvent is allowed to evaporate to avoid steam blisters under the heat cycle.

5 The wood surfaces are coated with an appropriate resin adhesive suitable for wood. The assembly time depends on the adhesive used, ordinarily 15 to 60 min.

6 The coated surfaces, wood and metal, are brought together, placed under simultaneous heat and pressure (approximately 250 to 300 F and 50 to 250 psi, respectively) for 10 to 30 min.

In some instances, especially with thicker metal, it may be desirable to cool down to 175 to 200 F, below the boiling point, before releasing pressure, to relieve internal stress. In most cases this has not been found necessary.

This type of metal-to-wood technique gives bonds of maximum strength and durability.

Adhesive-Coated Metal Surfaces, Two-Stage Process. There are instances where it is difficult to apply heat after metal and wood layers are assembled, but practical to apply and heat-cure an adhesive coating on the metal in a first stage, and complete the bond to the wood layer in a second operation with room-temperature adhesives.

[2] By N. A. deBruyne of Aero Research, Ltd.

In such cases the metal surface is prepared and dried as detailed under items 1–4. In order to produce a thin uniform coating, a copper plate or caul is placed against the uncured adhesive coating and this assembly is subjected to the standard heat pressure cycle. Copper resists adhesive action with practically all the metal-to-metal adhesives, and the result will be an adhesive-coated metal ready for normal gluing to wood under room-temperature conditions. If the coating is too smooth it may be slightly sanded. The use of resorcinol adhesives is preferred for this second-stage gluing.

This same goal of a metal adhesive coating may be secured in another way. The metal surface can be prepared as described in items 1 to 4. The coated metal can be inserted in an oven for cure without pressure. The result will be a rather rough hot-cured adhesive coating, which can be sanded to a uniform thickness for close fitting and gluable surfaces. The second adhesive operation is with a resorcinol adhesive that can be cured at room temperature and can be accelerated if desired by moderate heat.

There is an interesting advantage in this two-stage process, which in a number of instances justifies its use. The coefficients of expansion vary between different metals as well as between metal and wood. When the adhesive between metal and wood is cured under substantial heat, opposed internal stresses may be built up as the product is cooled to room temperature. In balanced constructions of substantial area these unfavorable stresses may result in somewhat weakened joints, while in unbalanced designs it may cause warping. These effects are more serious as the metal thickness increases and in very thin metals, approaching the foils, they may be negligible. In the two-stage process, where the final bond, or second step, of metal to wood is cured at room temperature, no such internal stresses are developed.

Film Adhesives for Wood-to-Metal. The wood-to-metal adhesives so far described have consisted of two components, and have been closely related to metal-to-metal adhesives. Another line of research has developed a Redux film,[3] a product in which the metal-to-wood adhesive is in film form, to be interleaved between the sheets or layers of metal and wood. This is the simplest and cheapest type of wood-to-metal bond where volume is sufficient to warrant the necessary equipment, such as annealing ovens, conveyers, hot press, etc. Its development, so far, has been on thin aluminum, from 0.010 in. up. The heat-cured bond is excellent for durability and its shear strength in wood-to-metal bonds closely approaches that of the wood itself.

Some modifications in the cleaning procedure are possible, such as the use of an annealing oven to degrease the metal, with cooling chambers and a conveyer direct to the lay-up table. This cleaning process, if properly conducted, passes a continuous water-film test satisfactorily, but the annealed sheets must be kept scrupulously clean, handled with clean gloves, and laid up and cured into plymetal within a few hours. Otherwise the degreasing must be repeated. The moisture content of the veneers should be between 7 and 10 per cent and of close thickness tolerances, in order to regulate the flow of the resin. Plymetal sheets, 3-ply, with 0.010-in. aluminum faces and $^1/_{16}$-in. veneer cores, give surprising strength and stiffness and can readily be punched for a multitude of industrial uses. This particular construction can be cured in 15 min at 275 F under 200 psi pressure. Under $3^1/_2$ soak-dry cycles the strength of this bond is not impaired; and under $10^1/_2$ soak-dry cycles or $2^1/_2$ boil-dry cycles the strength losses are less than 10 per cent.

[3] Resinous Products & Chemical Company.

METAL-TO-WOOD APPLICATIONS

Some of the metal-to-wood adhesive applications, briefly listed earlier in this paper, are of sufficient importance to warrant a more complete description. They are typical of many others that are in the process of development and give promise of even wider usefulness for such metal-to-wood combinations.

Sandwich Constructions. This term, "sandwich," has been recently adopted by the aircraft industry (3, 4, 5, 6, 7, 8) to describe a stressed-skin construction, which is in many cases flat, as contrasted with monocoque. Fundamentally it consists of two outer surfaces, which are dense and strong, combined with a center layer of low density, all glued together as an integral unit. The outer surfaces, which carry the greater proportion of the imposed load, may be high-density wood, laminated paper or cloth, metal, even normal hardwood plywood, or other types of strong material. The center layer may be end-grain balsawood, sponge rubber, foamed glass, or plastic, or even hollow, with or without separator strips or honeycomb supports (3). General sandwich designs are shown in Fig. 1.

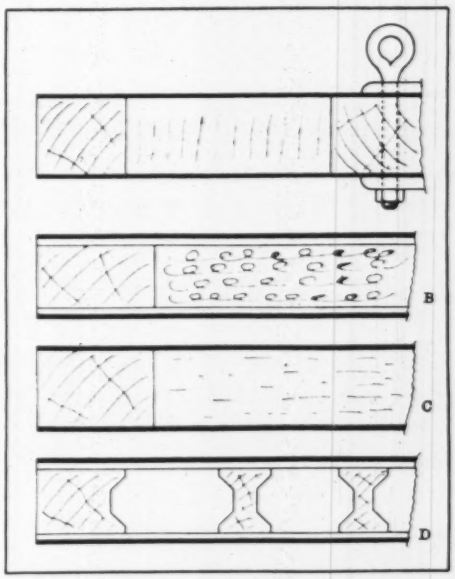


FIG. 1 TYPE OF SANDWICH CONSTRUCTIONS WITH METAL FACES (*A*, Aluminum face, with end-grain balsa core, one-step gluing under heat. *B*, Aluminum face, sponge core, with veneer interlayer, two-step gluing. *C*, Aluminum face, with side-grain balsa core, one-step gluing. *D*, Aluminum face, hollow center with stiffener strips and veneer interlayer, two-step gluing; reference 3.)

It is customary to supplement the relatively weak center with strong solid wood parts along the edges or in other locations where bolts or fasteners are anticipated. See Fig. 1(*A*).

Metal has received much attention as an outer surface, due to its combined hardness and strength, but its bonding to the low-density interior requires a careful technique to unite two materials of such widely differing physical characteristics. In general, the surface of the low-density center, shown as end-grain balsawood in Fig. 1(*A*) and (*B*), is sized or coated with a resin that tends to form a shallow semidense surface and retard further penetration of subsequent adhesives. This sizing is dried to reduce the hazard of steam blister under hot-pressing. The metal is cleaned, coated with Redux liquid and powder, and surplus solvent evaporated. After assembly, simultaneous heat and pressure are applied and must be adequate for the requirements of both the coating and adhesive resins. The fac-

tor of pressure requires careful regulation, enough to secure a thin glue line and not too much, which might crush the low-density core. In many cases metal thickness stops can be used between the heated press plates. The problem is one of securing an adequate cure for durability since the strength need be no greater than that of the low-density core.

An alternate procedure is to cure an adhesive coating on one side of the metal under heat as previously described in the two-stage process, presize and partly dry the adhesive on the core, and clamp the two parts under pressure for the period required by the room-temperature adhesives.

Still another method is to glue a thin sheet of veneer direct to the metal under heat as a first stage and make the second-stage bonding with room-temperature adhesives, as shown in Fig. 1(*B*) and (*D*).

Sandwich constructions properly designed and fabricated have phenomenal strength/weight factors, but the types are too varied to permit a tabulation of such values.

The famous Mosquito plane used sandwich construction extensively, both flat and monocoque, but with plywood faces. Its successor, the de Havilland Hornet (6, 7), a postwar development of great promise, uses many metal-wood combinations with adhesive bonds.

Industrial Structures. Plymetal has been used in flat sheets for industrial structures for some years. It has usually had a 16 to 24-gage steel or galvaneel face, customarily on one side only. In order to avoid warping in such unbalanced constructions it has, in general, been fabricated with room-temperature adhesives. Another method of reducing the tendency to warp is to interpose a layer of cloth or canvas between the metal and the wood, which is glued to both. The utilization of the new special resin adhesives gives more weatherproof bonds than can be obtained with earlier conventional glues.

Quite recently there have been some constructive developments, such as grooving and folding the edges of the plymetal sheet to increase stiffness and to improve the methods of erection. One of these interesting techniques[4] is that of V-grooving (90-deg angle) the plywood side through the wood to the metal, folding the metal at the groove, with or without a plastic filler, and bolting the bent flanges together as shown in Fig. 2. This results in a rigid wall, floor, roof, or partition. Regulation of the metal thickness, the width of the flange, the distance between flanges, as well as the type of plywood construction affords wide flexibility in design.

In general, 4 × 8 ft is the standard size in which this product is available. It can be grooved, punched, and bundled in the flat, before bending the edges, and thus be reduced to very compact packages for transportation.

Joists, girders, door jambs, and other structural members can also be made of these plymetal sheets in similar ways. Raw exposed edges can be cut back from the metal and folded over, if desired, for such openings as windows, doors, and the like.

Aluminum-Faced Veneer and Plywood. The plymetal just described has a metal face on one side, usually steel of substantial thickness, where severe service is anticipated.

A more recent development, Reynalite,[5] follows a somewhat similar method and utilizes very thin aluminum sheets on both sides of either a single sheet of veneer or of plywood, using Redux film. The aluminum is somewhat thicker (0.010 to 0.025 in.) than a foil so that it can be handled without wrinkling, and hence factors of expansion (between metal and wood) under heat are much less critical than with metal sheets of substantial thickness. It is essentially a balanced plywood construction, in which a normal single-ply veneer is used for the core while both faces are of thin aluminum instead of veneer. Plywood cores are used for thicker constructions.

Aluminum has two desirable characteristics, in comparison with steel; it weighs only one third as much as steel and it does not have to be protected against rust. When contrasted with yellow poplar (S.G. = 0.41), aluminum (S.G. = 2.81) is about 7 times as heavy. From a weight standpoint 0.010-in. aluminum equals $^1/_{12}$-in. veneer. Hence $^1/_8$-in. poplar with 0.010-in. aluminum faces would have approximately the same weight as 3-ply $^5/_{16}$-in. poplar plywood. The aluminum-faced material, however, would have moistureproof and nonrusting surfaces with higher strength values than the normal plywood.

This product is in the initial production stages and is undergoing pilot-plant tests for many industrial applications.

Stiffness Factors of Plymetal. There has been a third approach[6] to the adaptation of plymetal to structural and engineering problems, i.e., that of evaluating it from its stiffness characteristics. This is somewhat akin to the sandwich construction previously described, in which the center layer was chosen for extreme lightness. This third approach, however, considers normal types of plywood, $^1/_4$ in. and thicker, encased with steel or aluminum on one or both sides, and the variations in relative thickness of the different layers are infinite. An example of this evaluation, including four types, is given in Table 1. When the stiffness factors ($E \times I$) and the unit weight are known, the engineer and designer is in a position to use such plymetal products in an efficient and economical manner. There is abundant opportunity and urgent demand for the further development of useful data of this type.

Elevator Cabs and Enclosures. This specialized type of plymetal product may be variously constructed of several plies, depending upon the strength and stiffness required. Fundamentally, the metal is the back and serves as a fire-protective layer. An important type is one in which a layer of canvas is firmly attached to a steel sheet by a low-temperature solder, which is quickly quenched with water to avoid burning the cloth.[7] This cloth-backed metal is then glued to one or more layers of veneer or plywood by one of several adhesives, either employing the hot press or utilizing a room-temperature resin adhesive. Several constructions are shown in Fig. 3 and there are numerous other possible combinations.

The layer of cloth, when used with a thin veneer face, imparts

[4] United States Plywood Corporation.

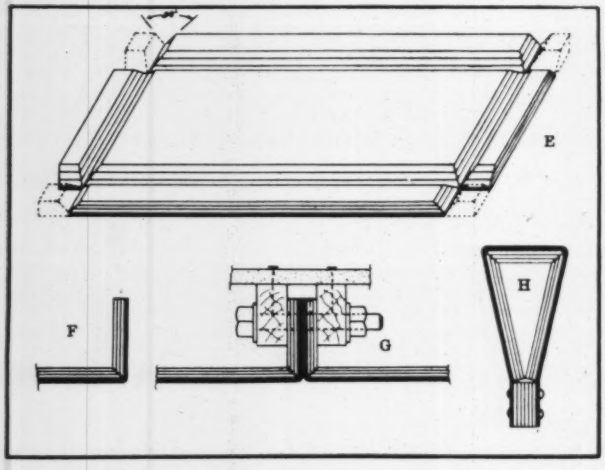


FIG. 2 ARMORPLY[4] FOR INDUSTRIAL STRUCTURES

(*E*, Sheet with V-groove on the plywood side. *F*, Same with edge folded at the groove. *G*, Wall joint prepared for inside fiberboard lining. *H*, Joist made by similar technique.)

[5] Reynolds Metals Company.

[6] "Plymetl" by Haskelite Manufacturing Corporation.

[7] H. H. Robertson Company.

TABLE 1 STIFFNESS FACTORS FOR PLYMETAL[a]

SHEET STEEL WITHOUT PLYWOOD					PLYMETAL THICKNESS INCHES	.021" STEEL, 1 SIDE ON PLYWOOD			.021" STEEL, 2 SIDES ON PLYWOOD		
THICKNESS DEC.	GA.	FRAC.	LBS. SQ. FT.	ExI		LBS. SQ. FT.	ExI⊥	ExI∥	LBS. SQ. FT.	ExI⊥	ExI∥
.056"	20		1.50	12.							
.060	16		2.50	56.							
.105	12		4.57	5.1							
.135	10		5.62	6.5							
.164	8		6.87	16.							
.194	6		8.12	20.							
.250	3	1/4"	10.2	89.	1/4"	1.46	1.9	3.6	2.45	11.	17.
.313	0	5/16	12.7	176.	5/16	1.82	3.8	6.2	2.60	47.	28.
.375		3/8	15.4	140.	3/8	1.77	5.4	12.	2.56	60.	45.
.438		7/16	17.3	210.	7/16	1.96	11.	18.	2.74	99.	64.
.500		1/2	20.4	310.	1/2	2.10	17.0	22.	2.89	76.	80.
.625		5/8			5/8	2.46	29.	43.	3.26	140.	150.
.750		3/4			3/4	2.74	48.	72.	3.48	180.	190.
.875		7/8			7/8	3.35	81.	110.	3.37	255.	269.
1.000		1			1	3.40	120.	150.	4.21	365.	359.
SHEET ALUMINUM WITHOUT PLYWOOD					PLYMETAL THICKNESS INCHES	.015" ALUMINUM, 1 SIDE ON PLYWOOD			.015" ALUMINUM, 2 SIDES ON PLYWOOD		
THICKNESS DEC.	GA.	FRAC.	LBS. SQ. FT.	ExI		LBS. SQ. FT.	ExI⊥	ExI∥	LBS. SQ. FT.	ExI⊥	ExI∥
.037"	16		.71	.11							
.075	14		1.14	.42							
.102	12		1.44	.87							
.125	11		1.91	1.8							
.158	8		2.59	5.0							
.50		1/4	4.52	14.	1/4"	.34	1.2	2.5	1.18	4.3	4.9
.63		5/16	5.66	28.	5/16	1.02	2.5	4.5	1.47	7.0	8.2
.75		3/8	6.41	41.	3/8	1.15	5.2	7.7	1.63	12.1	15.2
.88		7/16	8.17	61.	7/16	1.36	5.6	12.	1.81	18.	25.
1.00		1/2	7.36	110.	1/2	1.54	9.4	15.	1.65	20.	26.
1.25		5/8	9.20	230.	5/8	1.80	17.	28.	1.96	36.	45.
1.50		3/4	10.50	360.	3/4	2.15	29.	40.	2.15	56.	65.
1.75					7/8	2.10	40.	65.	2.55	81.	94.
2.00					1	2.70	70.	96.	2.58	116.	129.

⊥ = WITH TRANSVERSE GRAIN FACE (CROSSWISE) NEXT TO THE METAL.
∥ = WITH LONGITUDINAL GRAIN FACE (LENGTHWISE) NEXT TO THE METAL.
E = MODULUS OF ELASTICITY; I = MOMENT OF INERTIA; = STIFFNESS FACTOR.

[a] Table derived from semilogrithmic chart developed by Haskelite Manufacturing Corporation and used by permission.

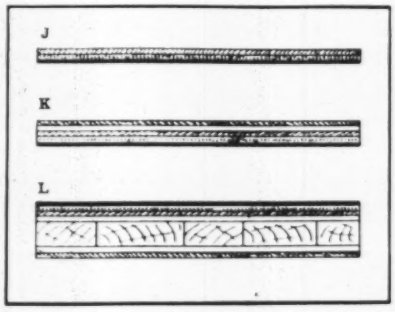


FIG. 3 ROBERTSON BONDED METAL

(*J*, Cloth-coated metal with single ply of decorative veneer. *K*, Cloth-coated metal faced with 3-ply decorative plywood. *L*, Cloth-coated metal face with 5-ply plain veneer as backing and stiffener.)

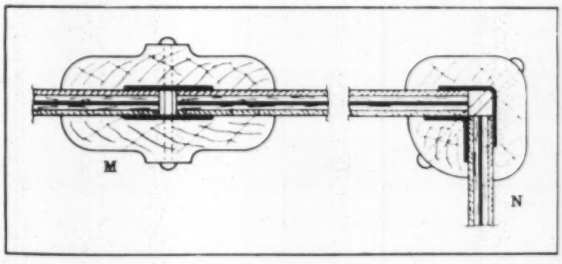


FIG. 4 PLYWOOD PARTITIONS WITH METAL CORES

(*M*, Section showing vertical joint with metal reinforcing strips in the molding. *N*, Section showing corner joint with inserted angles for reinforcement.)

considerable ductility to the product and such plymetal can be bent and curved to a surprising degree. The canvas also appreciably reduces the tendency to warping, since it provides a somewhat flexible and equalizing layer between the metal and the wood.

Office Partitions. This type of fireproof partition, with concealed metal interlayers, is sometimes required in restricted and zoned areas in large cities. The plywood is made with a sheet-metal core, under any of the methods previously described. The sketch in Fig. 4 indicates not only the plymetal construction, but the method of assembling and erecting the partitions.

This method permits the use of natural wood finishes to harmonize with the other office equipment and interior trim. At the same time protective metal strips are incorporated to reinforce the wood moldings at every joint, thus producing a continuous noncombustible metal barrier.

Cigaretteproof Desk Tops. This is a recent development, resulting from the discovery that a thin metal layer, scarcely more than an aluminum foil, directly under the face veneer, will dissipate and distribute the heat resulting from a lighted cigarette. Tests have shown[8] that with such metal interlayers no burns or discolorations occur in a highly figured face veneer, providing the finish is heatproof.

Since cigarette burns have been an annoying cause of damage and defacement on desk tops of wood construction, this new technique is receiving study and careful consideration not only from manufacturers of office desks and tables, but also from

[8] Timber Engineering Company, Washington, D. C.

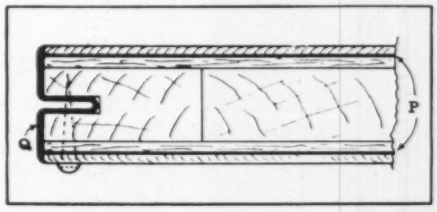


FIG. 5 CIGARETTEPROOF DESK TOP

(*P*, Aluminum interlayers. *Q*, Protective metal edge around top.)

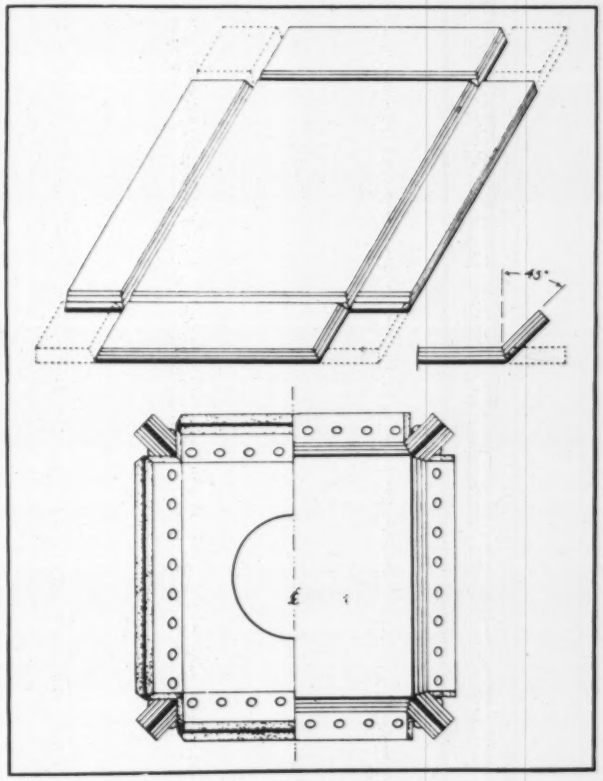


FIG. 6 PLYMETAL POWDER CHEST

(*Upper*, Flat sheet with V-grooves for folding to 45 deg. *Lower*, Assembled outside view at left and interior view at right.)

makers of a wide line of case goods, occasional tables, and smokers' stands. The cost of inserting this thin aluminum layer is rather slight and the advantages far outweigh the cost.

Such desk tops and writing beds are usually a 5-ply construction, with lumber core, and the extra metal layer is easily inserted so that the adhesive for both wood and metal joints can be cured under the same heat-pressure application. Redux film, with properly cleaned aluminum, about 0.006 in. therefore adds to the standard desk top only the cost of the metal and the metal adhesive. A section of such a typical construction is shown in Fig. 5.

Metal-Lined Powder Chest. This is a war product and is a notable example of Yankee ingenuity. The earlier type of powder chest comprised an inner watertight and moisture-proof can of zinc or stainless steel, with a separate outer crate or case of wood (protective jacket) to guard the inner can from damage in handling or shipping. It was believed that bulk and weight could be reduced without increasing the cost appreciably, although on military projects cost was not as serious a limitation as on civilian products.

The development[4] consisted of a stainless-steel layer glued to 3-ply Douglas-fir plywood. This plymetal was then cut with V-slots (45-deg groove) on the plywood side down to the metal; the superfluous corners were removed and the flaps folded to 45 deg, preparatory to assembly with bolts or screws, all as shown in Fig. 6. The bolted joints could be filled with a calking compound or welded inside for tight corners. The last weld can be made through the bung (6 in. diam) after the bottom is bolted in place. The resulting plymetal case was found equal to the earlier type, conserved metal, was lighter, was reasonable in cost, and proved to be easier to handle. Specifications were accordingly approved and many thousands of these plymetal powder cases were sent to the battle areas.

NONPLYWOOD APPLICATIONS

The problems classified under this head include tool handles, where riveting technique is superseded, metal-reinforcing plates where wood parts are to be bolted together, impact or bearing plates over wood areas where abrasive action is severe, and other applications where metal-faced wood combinations are useful.

There are several solutions to these problems, some of which do not require heat penetration through any substantial thickness of wood, since this is time-consuming and sometimes tends to deteriorate the wood if heat is applied for too long a time.

Metal faced with a cured adhesive coating, as previously described, is one of the more common. This is a two-step process; (*a*) curing the coating on the metal under simultaneous heat and pressure, followed by (*b*) using a room-temperature adhesive for the final bond to the wood. Sometimes a thin sheet of a strong veneer is glued to the metal in step (*a*) in which case step (*b*) is a regular wood-to-wood joint.

In some instances, where the bulk of the wood part permits the use of a hot press and does not dissipate the heat too rapidly, a direct one-step bond (metal to wood) may be made with Redux liquid and powder as outlined earlier in this paper.

Knife Handles. An example[9] of a glued knife handle, indicating the various successive steps, is shown in Fig. 7. In this case a dozen or more assembled knife handles were clamped together, while the wood strips were still flat, and placed in an oven for the required curing cycle. The metal handle bases served to transmit the heat directly to the adjacent glue lines, and thus reduce the curing-time requirements considerably below what would be needed for the heat to penetrate through the wood. The same factor would be effective where wood clips are glued directly to the blade.

[9] Hyde Manufacturing Company.

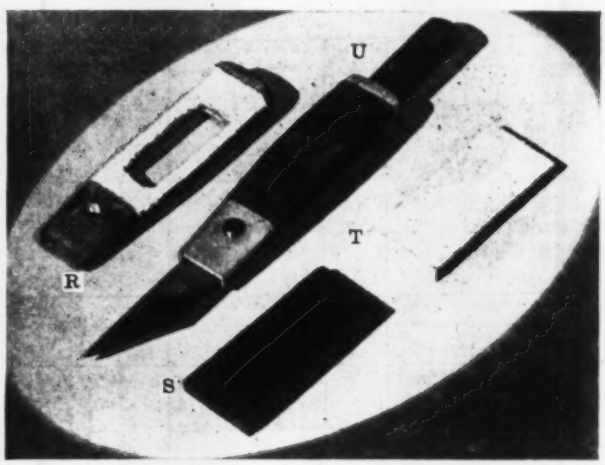


FIG. 7 RUBBER KNIFE WITH WOOD-TO-METAL GLUING

(*R*, Cast Dowmetal handle base with Redux liquid and powder applied. *S*, Wood strip coated with liquid only. *T*, Wood strip after powder applied over liquid. *U*, Assembled handle and blade before final finishing.

CONCLUSIONS

Enough data have been presented to indicate some of the more obvious combinations of plywood and metal layers[10] that have been found useful. Much more remains to be done. It can be reasonably expected, now that the fundamentals of wood-to-metal gluing have been established, that many new applications will be found by the creative ingenuity of the American manufacturer.

[10] A number of the products and processes are covered by U. S. and foreign patents. Prospective users should investigate such situations carefully.

BIBLIOGRAPHY

1 "Modern Wood Adhesives," by T. D. Perry, Pitman Publishing Co., New York, N. Y., 1944, pp. 58–77.

2 "Plywood and Metal Faced Plywood," by Armin Elmendorf, *Aviation*, vol. 19, Aug. 24, 1925, p. 215.

3 "A Lightweight Floor for Airplanes," by J. R. Fitzpatrick, MECHANICAL ENGINEERING, vol. 66, 1944, pp. 705–709.

4 "Buckling of Sandwich Type Panels," by N. J. Hoff and S. E. Mautner, *Journal Aeronautical Sciences*, vol. 12, July, 1945, pp. 285–297.

5 "Sandwich Structures and Core Materials," by various authors, *Modern Plastics*, vol. 22, July, 1945, pp. 127–131, and 132–135.

6 "The deHavilland Hornet," *Aeroplane* (London), vol. 70, Jan. 25, 1946, pp. 107–111. *Flight* (London), vol. 49, Jan. 24, 1946, pp. 85–90.

7 "DeHavilland Hornet," by E. Goff, *Aircraft Production* (London), vol. 8, part I, May, 1946, pp. 211–222; part II, June, 1946.

8 "Metal-Balsa Sandwich," *Scientific American*, vol. 174, June, 1946, p. 254.

9 "Survey of Adhesives and Adhesion," by R. C. Rinker and G. M. Kline, National Advisory Committee for Aeronautics, Technical Note 989, Aug. 1945.

10 "Strength of Glued Joints," by N. A. debruyne, *Aircraft Engineering* (London), vol. 16, April, 1944, pp. 115–118, 140.

11 "Bonding Metal-to-Wood" (Cordo-Bond), by C. M. Grafton, *Modern Plastics*, vol. 22, Sept., 1944, pp. 103, 194, 196.

12 "Plastic Bonding of Light Metals" (Araldit), by E. Preiswerk and A. von Zeerleder, *Plastics* (London), vol. 10, July, 1946, pp. 357–360.

13 "Wood Handbook," revised edition, Forest Products Laboratory, Madison Wis., 1940, pp. 50–53.

14 "Plastic Progress" (Pastel and Ardux), by W. Nichols, *Flight* (London), vol. 42, Oct. 29, 1942, pp. 475–477.

15 "The Stresses in Cemented Joints," by M. Goland and E. Reissner, Trans. A.S.M.E., vol. 66, 1944, p. A-17.

16 "Metal Plus Plastics Makes New Aircraft Flooring," *Aviation*, vol. 43, April, 1944, pp. 130–131, 240, 243.

17 "Adhesives for Metals and Nonmetals," by Kenneth Rose, *Metals and Alloys*, vol. 20, 1944, pp. 959–960, 962–963.

Passenger-Car ELECTRICAL *and* HEATING EQUIPMENT

Analysis of Equipment Weight Reduction in Modern Railway Cars

By H. H. HANFT

TRANSPORTATION APPLICATION ENGINEER, WESTINGHOUSE ELECTRIC CORPORATION, EAST PITTSBURGH, PA.

DURING the last decade, substantial progress has been made in reducing the weight of railroad passenger cars. A study of recent car designs indicates that the weight of a standard coach, ready for service, will be approximately 100,000 lb, far less than the standard coach of the "mid-thirties." This weight economy has resulted largely from careful redesign of trucks and the scientific use of low-alloy high-tensile-strength steels in car bodies and underframing. A breakdown of component parts shows that the structural shell of a car accounts for approximately 30 per cent of the total weight, and it is apparent that modern design can reduce the weight of trucks so they, too, do not exceed 30 per cent of the total car weight. The remaining 40 per cent consists of interior furnishings, seating, heating, lighting, air conditioning, batteries, and power supply. This paper deals with the possibility of weight reduction in heating and air-conditioning equipment and in battery and power-supply equipment.

SELF-CONTAINED PASSENGER-CAR POWER SYSTEMS

Modern passenger cars are heated almost universally by finned-copper floor-mounted steam-radiation systems. They are powered either by axle-driven direct-current generators or gas-engine-driven direct-current generators, in conjunction with storage batteries of sufficient capacity to carry electrical loads for a reasonable time at low speeds and at standstill. Air conditioning is provided by direct-current electromechanical refrigerant compressors, by steam-jet systems, or by gas-engine-driven refrigerant compressors. The weights of such systems may be broken down into component items, including power supply, battery, cooling equipment, heating equipment, air cleaning, miscellaneous, wire and cable, conduit, and fittings.

In existing 1946 designs the weight of these items varies from 13,836 lb to 16,063 lb, or from 13.8 to 16.1 per cent, respectively, of the total weight of a passenger coach. It is this weight with which the remainder of this paper is concerned.

In the interest of simplification, the discussion is restricted to a standard 85-ft passenger coach. Interior arrangement of club cars, dining cars, grill cars, and sleeping cars will cause the weight of component parts discussed to vary, but for a given type of car, relative weight of the components will change but little for the several types of systems discussed. Similarly, car lighting will vary considerably, according to the designs used. For that reason fluorescent and incandescent lighting have been eliminated from the discussion. They represent a relatively small part of the total weight of car equipment.

There are approximately 14,000 air-conditioned railroad passenger cars operated in this country today. During the last 3 years of unrestricted construction before the war, new building was confined almost exclusively to three types of air conditioning as follows: electromechanical, steam-jet; gas-engine-driven.

Electromechanical systems are served by axle-driven direct-current generators, 32, 64, or 110-v storage batteries, and direct-current electromechanical air-conditioning equipment. A breakdown of equipment weight appears in Table 1. This weight analysis is based on design of 1946 cars.

Because heat zoning varies considerably, according to the desires of individual railroads, and the type of zoning and control used affects the weight of the heating system, the weight of heating equipment shown in the tabulation includes only finned copper radiation and a nominal control panel. These items remain practically constant in weight for given heating requirements. The 910-lb weight of heating equipment is used for all conventional systems discussed.

Total weight of the axle-generator-powered electromechanically air-conditioned car equipment is 16,063 lb. The system provides from 8 to 9 tons of cooling capacity, depending upon operating conditions.

A second type of car utilizes a smaller axle generator to power electrical equipment and to charge the car battery. Air conditioning is provided by a steam-jet system, reducing the car electrical load by eliminating the electrically driven refrigerant compressor. This system, providing from 6 to 7 tons of cooling capacity, weighs 14,762 lb; details appear in column 2 of Table 1.

Another car power system eliminates the axle generator entirely, producing power on the car by means of a gas-engine-driven generator, to drive electrical equipment and charge a smaller, 400-amp-hr, lead storage battery. A second gas engine drives the refrigerant compressor to provide cooling on the car. The weight of electrical cooling and heating equipment on this car totals 12,289 lb, including an air refrigerant condenser with evaporative subcooler, giving 6 tons of nominal cooling capacity. Inclusion of a full evaporative condenser as on the cars discussed previously brings total equipment weight up to 13,836 lb. The weight of component parts is given in column 3, Table 1.

The three types of car already mentioned utilize direct-current power supply of either 32, 64, or 110-v potential. They carry a motor alternator or other conversion unit to provide alternating current for serving fluorescent lighting, utility outlets, and other devices requiring a source of alternating current. The weight of battery, electric wiring, conduit, and motor alternator on these cars varies between 4335 lb and 7863 lb, or 31.3 to 48.9 per cent, respectively, of the total weight of equipment under discussion.

HIGH-VOLTAGE EQUIPMENT TO SAVE WEIGHT

The weight of these items may be reduced to less than 15 per cent of equipment weight by operating car electrical equip-

Contributed by the Railroad Division and presented at the Annual Meeting, New York, N. Y., December 2–6, 1946, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

TABLE 1 WEIGHT COMPARISON, PASSENGER-COACH ELECTRICAL AND HEATING EQUIPMENT; FOUR TYPES OF CAR POWER GENERATION AND AIR CONDITIONING

Item	Axle generator d-c air conditioning, lb	Axle generator steam-jet air conditioning, lb	Gas-engine generator, gas-engine air conditioning, lb	Diesel-engine generator, a-c air conditioning, lb
Power supply	2529	1943	2737	4814
Battery	4801	4801	1997	960
Cooling equipment	4525	4534	5618	4058
Heating equipment	910	910	910	1314
Air cleaning	56	56	56	56
Miscellaneous	740	740	740	163
Wire and cable	1058	613	613	225
Conduit and fittings	1444	1165	1165	452
Sound insulation	...	...	...	352
Totals	16063	14762	13836	12394
Omit 896 lb emergency floor heat in full train-line operation				11498
Weight economy on a-c car	4565 lb (28.4 per cent)	3264 lb (22.1 per cent)	2338 lb (16.9 per cent)	...

ment from a source of relatively high-voltage alternating current carried on the car. Such a car recently was placed in service in this country. A detailed analysis of equipment weights on this car appear in the last column of Table 1.

Three-phase 220-v 60-cycle alternating-current power is supplied by a Diesel-engine-driven 30-kva generator mounted in the car body. The generator is excited dually, to assure satisfactory voltage regulation at all loads. No-load excitation is provided by a small lead storage battery, which is floated across a selenium-rectifier charger served by the alternating-current generator. As generator load increases, series transformers in the three generator leads supply additional excitation through another selenium rectifier serving a second generator-field circuit. The engine generator is mounted on slide rails, and may be removed as a unit for servicing.

Cooling capacity of from 8 to 9 tons is provided by an air-conditioning unit powered by hermetically sealed alternating-current refrigerant compressors. The entire cooling assembly may be removed from the car without breaking any refrigerant lines.

The car is heated normally by utilizing the heat lost to the Diesel-engine cooling system, supplemented by electric strip heaters mounted near the car floor, and in the fresh-air-intake ductwork. A thermostatically modulated valve controls forced circulation of hot engine-jacket water through an overhead hot-water finned-copper heating coil located in the main car air duct. Air forced through the duct by the car air fan is heated before being distributed throughout the car. The electric floor heaters provide additional localized heat, and load the generator and engine, to assure sufficient heat loss to the engine cooling water, and overhead hot-water heating coil.

To assure proper heating in the event of Diesel-engine or generator failure, a finned copper steam-heat coil is located in the overhead car air duct, directly adjacent to the hot-water coil. Steam may be admitted to this coil from the steam-heating train line in emergency, and the car is heated by air circulated by the car air fan. Power to drive the fan is derived from adjacent cars arranged for train lining of power circuits.

The car also carries a full set of finned copper floor radiation, to be served by the steam train line, in the event that adjacent cars should not be equipped with the Diesel-engine-generator system arranged for power train-lining.

The car battery is considerably smaller and lighter than those used with other systems. It has ample capacity to crank the Diesel engine and to carry emergency lighting for a 10-hr period. The battery circuit is train-lined.

A centrifugal air cleaner removes much of the dirt and dust present in the 800 cu ft of fresh air drawn into the car for ventilation. An electrostatic air cleaner, Precipitron, further cleans the air and removes tobacco-smoke particles from recirculated car air. The car air fan forces 2400 cu ft of fresh and recirculated air per minute through the Precipitron.

Generation of alternating-current power on the car makes possible the use of commercially developed alternating-current apparatus, including an alternating-current water cooler. The 4-kva motor alternator is eliminated, along with its additional weight and maintenance. The resultant weight economy totals 630 lb.

The use of 220-v alternating current in power circuits effects a substantial reduction in the weight of wire, cable, and conduit on the car. These items weigh from 1778 to 2502 lb on the other types of cars considered, or from 13 to 15 per cent of total equipment weight. Cable and conduit on the alternating-current car weigh 677 lb or 5.9 per cent of the total equipment weight.

The total weight of electrical and heating equipment on the car is 13,289 lb. To arrive at a system weight comparable to that of the three cars already discussed, weight of the emergency floor heating and added air-cleaning equipment should be deducted, giving a net comparable weight of 11,498 lb for an alternating-current car operated in a train with other cars similarly equipped.

As indicated in Table 1, equipment on the alternating-current car is from 16.9 to 28.4 per cent lighter in weight than that on cars of conventional design.

HEAD-END POWER SYSTEMS

Still further reduction in the weight of passenger-car electrical and heating equipment may be achieved when power is generated at the head end of the train. Such a system requires train-lining of power and control circuits of all cars in the train.

The connected load on an all alternating-current air-conditioned passenger car approximates 16.5 kw, distributed as shown in Table 2.

TABLE 2 DISTRIBUTION OF CONNECTED LOAD ON A-C AIR-CONDITIONED CAR

	Kilowatts
Two 5-hp air-conditioning compressors	10.400
One 1½-hp car air circulating fan	1.450
One ½-hp air precleaner fan	0.600
One ⅓-hp evaporative condenser pump	0.325
One electrostatic air cleaner	0.090
One set fluorescent lighting	3.000
Two exhaust fans	0.200
One water cooler	0.215
One set control	0.150
Total connected load	16.430[a]
[a] Twin dining car with full-electric cooking	72.000

A train of 14 passenger coaches, carrying a twin diner, has a total connected load of 302 kw.

Two methods of head-end power generation have been studied. One involves use of a steam-turbine generator mounted in a recessed compartment across the rear of the locomotive tender. The main steam valve is located at the fire-

man's position in the locomotive cab. A generator speed indicator gives the fireman a check on operation of the set. A separate steam line with flexible connection may be run to the turbine or an oversize steam-heating line may be installed to carry steam to the turbine. The turbine exhausts to atmosphere with an exhaust stack designed to lift the steam well above the train. Turbine nozzles are proportioned so that rated capacity is developed at steam pressure as low as 80 per cent of rated inlet pressure. The turbine generator set has a nominal rating of 250 kw with a 2-hr overload capacity of 25 per cent. Three-phase 60-cycle 450-v power is generated for transmission throughout the train. Detailed information on the power unit appears in Table 3.

TABLE 3 WEIGHT ANALYSIS, HEAD-END POWER GENERATION, THREE-PHASE 450-V 60-CYCLE POWER SUPPLY

	Steam-turbine generator	Diesel-engine generator
Nominal generator rating, kw	250.0	250.0
Two-hour overload capacity, per cent	25	25
Generator rpm	1800	1800
A-c generator voltage, v	450	450
Frequency cycles	60	60
Phase	3	3
Dimensions of set:		
Length, ft-in	8-0	11-3
Width, ft-in	3-6	4-0
Height, ft-in	4-0	5-0
Estimated weight of set, lb	10000	13500
Generator control, switchboard, lb	1500	1500
Engine-starting-battery details, lb	...	960
Strengthening car structure, lb	...	3500
240 gal fuel, tank, piping, lb	...	2600
Total weight, lb	11500	22060
Added weight per car (16 cars), lb	718	1378
Locomotive boiler pressure, psi	225	
Turbine-inlet pressure, psi	200	
Steam temperature, deg F	650	
Turbine back pressure, psi	5	
Diameter steam-inlet pipe, in	3	
Diameter steam-exhaust pipe, in	6	
Steam consumption, 100 per cent load, lb per hr	7500	

The second source of head-end power investigated is a Diesel-engine generator carried on a leading car. It has the same rating as the turbine generator. Additional information appears in Table 3.

Estimated weight of head-end power generation details is 11,500 lb for the turbine set and 22,060 lb for the Diesel set, including 240 gal of fuel for 12 hr of operation at full rated load of 250 kw.

Control is provided to prevent electrical equipment on all cars from starting simultaneously when the power train line is first energized in the yard. It is arranged so that all equipment in one car must start and run normally before the train-line contactor on the next car in the train can close. The result is a gradual build-up of load on the head-end generator, with only slight frequency and voltage variation on cars already energized.

The weight of electrical and heating equipment in a car, arranged for head-end power supply, is developed in Table 4. Weight of many of the component parts is taken from Tables 1 and 3. Major weight economy is achieved in power supply, battery, wire and cable, and conduit.

Assuming a 14-coach train with a twin diner, equipped for all-electric cooking, and prorating the weight of head-end power details, the heating and electrical equipment weights on all systems discussed thus far are given in Table 5.

Prorated weight of the steam-turbine head-end power unit does not include the weight of water and coal required to generate steam for the turbine. To that extent, the equipment weight of 8295 lb requires explanation. Variations in the time and distance between coal and water stops on different train runs, and in steam rates of locomotive boilers, precludes selection of a representative weight of coal and water to be carried. A suitable figure may be calculated for any specific run. Actually, the water and fuel consumed by the turbine are more than canceled out by the steam required to carry axle-generator load.

TABLE 4 WEIGHT ANALYSIS, PASSENGER-COACH ELECTRICAL AND HEATING EQUIPMENT, HEAD-END POWER SUPPLY 8 TO 9 TONS OF 220-V A-C COOLING CAPACITY

	Pounds
Power Supply:	
270 ft of 250,000 cm train-line cable (600 v)	233
90 ft of 2-in. standard wall train-line conduit	329
6 Train-line receptacles	150
3 Train-line power jumpers	150
1 15-kva transformer 440-220-110-v	135
1 Train-line contactor, 3-phase	100
1 Battery-charging rectifier panel	65
2 Wayside power receptacles	36
1 Master control panel, equipped	230
	1428
Battery:	
As on a-c car, Table 1	960
2 Battery train-line receptacles	16
1 Battery train-line jumper	9
	985
Cooling Equipment:	
As on a-c car, Table 1, less hot-water coil	3968
Heating Equipment:	
1 Set finned copper floor heat, control panel	910
Air-Cleaning Equipment:	
4 Air filters	56
Miscellaneous Equipment:	
1 Water cooler, exhaust fans, Table 1	105
Wire and Cable:	
1 Set power and control wiring	79
Conduit and Fittings:	
1 Set conduit, fittings, Greenfield	46
Total weight, car electrical and heating equipment	7577
Equivalent car weight, including head-end details:	
Steam-turbine generator, add 718 lb	8295
Diesel-engine generator, add 1378 lb	8955

TABLE 5 HEATING AND ELECTRICAL EQUIPMENT WEIGHTS ON 14-COACH TRAIN

Type of Equipment	Equipment weight, lb	Percentage of base car weight per cent
Axle generator, d-c air conditioning	16063	100.0
Axle generator, steam-jet air conditioning	14762	91.9
Gas-engine generator, gas-engine air conditioning	13836	86.1
Diesel-engine generator, a-c air conditioning	11498	71.6
Head-end power, Diesel engine	8955	55.8
Head-end power, steam turbine	8295	51.7

EFFECT OF CAR EQUIPMENT ON TRAIN PERFORMANCE

Any reduction in train weight reduces the load on a locomotive, especially on adverse grades. In a 16-car train the alternating-current car reduces train weight by 73,040 lb, as compared to the base car with axle generator and direct-current air conditioning. ($16 \times 4565 = 73{,}040$ lb.)

Use of engine generator sets is equivalent to increasing net locomotive horsepower available for traction, by an amount equal to the horsepower drag of axle generators otherwise carried on each car. When axle generators carry the full connected electrical load on a car, plus 5 kw for battery-charging, their

combined output on a 16-car train is 382 kw or 512 hp. With 85 per cent generator efficiency and 95 per cent drive efficiency, the total axle-generator drag is 634 hp at the rail, nearly 20 per cent of the rail horsepower of many large passenger locomotives now in service. Scheduled speeds may be increased considerably by eliminating axle-generator drag.

Steam-turbine generator sets also increase net available locomotive traction horsepower through more efficient use of steam and elimination of battery-charging load. At a total load of 302 kw the turbine uses 9060 lb of steam per hr. The locomotive requires approximately 22 lb of steam per rail-horsepower-hour, or 13,948 lb to carry the 634-hp axle-generator drag. The hourly saving of 4888 lb of steam means 222 additional locomotive horsepower available for traction.

WEIGHT REDUCTION OF ELECTRICAL EQUIPMENT

Designers of electrical equipment for railroad service long have known the urgent need for compact lightweight motors and controls. Table 6 gives a weight comparison between comparable traction motors of 1917 and 1946 design, indicating progress made in reducing the weight of rotating electrical equipment.

TABLE 6 WEIGHT COMPARISON BETWEEN TRACTION MOTORS OF 1917 AND 1946 DESIGN

	1917 Motor	1946 Motor
Rated d-c voltage, v	600	600
Continuous speed, rpm	520	1820
Continuous horsepower rating	50	55
Weight, less gears, lb	2395	700
Weight per horsepower, lb	47.9	12.7
Weight reduction, lb per hp, per cent	....	73.5

This progress in motor design has been utilized in the construction of rotating electrical equipment for passenger-car service. A weight analysis of component parts of the 4-kw motor alternator referred to in Table 1 is presented in Table 7.

The sections and weight of the frame barrel and magnetic iron are determined by magnetic characteristics of the design. To obtain suitable voltage regulation, the iron is worked on the straight-line portion of the saturation curve. Any attempt to save weight by reducing the area of these sections would affect performance of the machine adversely. Reduction in copper section would have a similar effect and would result in excessive operating temperatures.

Front and rear brackets, totaling 73 lb in weight are of cast steel. From one half to one third of this weight could be saved by using aluminum or magnesium castings.

There is additional opportunity for weight reduction in the finned-copper-tube construction of refrigerant condensers, subcoolers, evaporators, and copper connecting lines. Several of the problems involved must receive further study before designs can be prepared, based upon substitution of aluminum or magnesium alloys in this class of equipment.

SUMMARY AND CONCLUSION

The weight of electrical and heating equipment on modern self-powered railroad passenger coaches varies between 13,836 lb and 16,063 lb, or between 13.8 and 16.1 per cent, respectively, of total car weight. These figures apply to air-conditioned coaches utilizing direct-current electrical equipment. Equivalent equipment on a car powered by Diesel-engine-generated alternating current weighs less than 12,000 lb, an equipment weight reduction of from 16.9 to 28.4 per cent. On a train equipped with a source of head-end alternating-current power, the equipment weight per car is reduced to less than 9000 lb.

Rotating electrical equipment designed for railroad service already has been reduced in weight to a point beyond which possibility of further weight economy is limited. Some reduction of weight is possible through use of aluminum- or magnesium-alloy sheet and castings on structural parts of the machines.

The use of lightweight alloys in fans, equipment structures, and refrigerant circuits offers promise of additional substantial weight economy.

TABLE 7 WEIGHT ANALYSIS OF 4-KW ALTERNATOR

Steel frame:	Pounds
Barrel, feet	160.3
Front and rear brackets	73.0
Shaft	24.0
Ball bearings and caps	11.0
End cover, dust shields	10.4
Total	278.7
Magnetic iron:	
Armature punchings	25.5
Pole pieces	34.1
Total	59.6
Copper windings:	
Armature copper	21.7
Field copper	70.5
Leads, wiring around frame	8.3
Total	100.5
Miscellaneous	11.2
Total weight	450.0

Neutralene Gas Producer

A NEW Neutralene gas-producing equipment providing a neutral, CO_2-free, dry, combusted gas for heat-treating medium- and high-carbon steels without decarburization has been announced by the Industrial Heating Division of the General Electric Company. The Neutralene gas atmosphere is especially suitable for bright annealing, clean-hardening, and furnace brazing of medium- and high-carbon steels, hardening of high-speed steels, and sintering of high-carbon ferrous metals. The basic unit of the new equipment is a complete and portable assembly, mounted on a single base and interconnected with piping and wiring.

Differing from the conventional system of using an atmosphere gas converter plus a CO_2-removal equipment, the Neutralene producer consists of a combined combustion chamber and reactivating tower, CO_2-absorbing tower, gas cooler, heat exchanger, and liquid cooler. For drying the gas, a refrigerated gas cooler and an activated alumina drier are furnished.

The analysis of Neutralene gas may be varied over a relatively wide range for specific applications. A typical mixture, suitable for heat-treating, sintering, and brazing, consists of about 10.5 per cent carbon monoxide, 15 per cent hydrogen, 1.5 per cent methane, and 73 per cent nitrogen (dew point 40 F). Freedom from carbon dioxide and water vapor eliminates any decarburizing action, and inclusion of carbon monoxide and a small amount of methane provides a slight carburizing tendency, overcoming any action of impurities which might enter the furnace atmosphere.

The Neutralene system saves about 18 kwhr per thousand cubic feet of gas produced, or more than $1000 per 6000 hr year with a power rate of one cent per kwhr. This is because the energy previously wasted in the water jacket of the atmosphere gas converter is now utilized. The combustion chamber of the converter is built into and supplies heat to the boiler of the reactivating tower, which was formerly electrically heated.

HYDROGEN PEROXIDE *for* PROPULSIVE POWER

Production and Use by the Germans During World War II

By CAPT. LOGAN McKEE, U.S.N.

THE use of hydrogen peroxide for propulsion purposes has been referred to from time to time in the public press. Certain details of the applications have of necessity been restricted, and similar restrictions still apply to some phases of the subject. However, there are features of the use of this material for power production, particularly by the Germans during the last war for V-bombs and for propelling airplanes and submarines, which are not restricted, and which it is felt would be of engineering interest.

CHEMISTRY INVOLVED

The formula for hydrogen peroxide is H_2O_2, and the material we will deal with is further defined by giving the per cent concentration, i.e., it is normally manufactured at about 27 per cent concentration. If a higher concentration is required, it is distilled under low absolute pressure, starting at about 50 mm Hg and decreasing the pressure to about 30 mm as the concentration is increased to 85 per cent. When used as a disinfectant the concentration is about 3 per cent, the remaining 97 per cent being water.

The Germans used a concentration of 80 to 85 per cent for 26 different war weapons and had it in an experimental stage for 40-odd others. They gave it a cover name of "Ingolin." Professor Walter, who was the foremost proponent of its use in Germany, named it after his eldest son, Ingol. It is also known there as "T-stoff."

It was sometimes used as a monofuel or primary fuel, i.e., using only the heat of dissociation of the H_2O_2 into H_2O plus O_2. The heat of dissociation for 80 per cent concentration is roughly 1000 Btu per lb. The mixture, in that case, would be 80 per cent H_2O vapor (superheated steam) and 20 per cent O_2 by volume (63 per cent H_2O and 37 per cent O_2 by weight), and the mixture would be at 500 C (932 F), assuming that the liquid was supplied at 70 F. It was, however, used more often as a secondary fuel, i.e., all or nearly all of the free oxygen was further burned with a fuel, such as decalene (which is similar to Diesel oil) or methyl alcohol. The reaction would, in some applications, take place all in one step by the use of a liquid catalyst and fuel combined. The Germans named the liquid catalyst and fuel mixture they used "Helmann" after Walter's second son. Their mixture was hydrazine hydrate and methyl alcohol. The reasons for using the material as a secondary fuel is to take advantage of the larger heat release per pound of mixture and also because the dollars and cents cost per Btu obtained from fuel is much less for that than from H_2O_2.

It will be noted from the foregoing that the heat of dissociation of H_2O_2 per pound is about 1/19 of that of the heat of combustion of a pound of oil. The value of H_2O_2 is therefore its ability to furnish free O_2 when and where you want it. It has advantages over liquid or gaseous oxygen in that it is more easily contained and it produces a lower flame temperature.

PRODUCTION OF H_2O_2 IN THE UNITED STATES

Prior to and during this war, H_2O_2 in this country was not concentrated for commercial or military purposes at greater than 50 per cent, although some laboratory tests had taken it higher. The reason it had not been taken to higher concentrations is that, unless certain rules are known and carefully observed, it is violently unstable and, naturally, the danger increases with the concentration. It follows that the Germans were far more advanced in the subject than any other country. We have been interested in it in this country for years, but did not reach the point of taking advantage of its characteristics in the higher concentrations. We now can and do concentrate it commercially to a higher percentage than the Germans ever did and to a greater degree of purity. For example, the Buffalo Electro-Chemical Company will supply it at 90 per cent concentration with only 5 parts per million impurities. Du Pont can do about the same. The Germans usually had much greater amounts of impurities, some of them not very harmful.

The foregoing will give an idea of the order of the concentrations used.

CHARACTERISTICS OF HYDROGEN PEROXIDE

In the concentration used by the Germans, the specific gravity is 1.37 at 32 F. It is colorless or slightly yellow and has a distinctive, but not unpleasant, odor. The 100 per cent concentration freezes at 20 F, and boils at 306 F at atmospheric pressure, and its specific gravity at 32 F is 1.46 plus. A peculiar thing is that 80 per cent H_2O_2 freezes at 11 F and, of course, 1 per cent at just under 32 F; 60 per cent solution freezes at —70 F. The boiling point at atmospheric pressure has to be obtained by extrapolation as the material detonates before reaching the boiling point. Concentration is determined usually by taking its specific gravity, although titration gives a more accurate check. Impurity in the form of sulphuric acid throws off the determination of concentration by observations of the specific gravity and this gave the Germans so much trouble that they learned to eliminate the H_2SO_4.

After a stabilizer (or stabilizers) is added, (the Germans used oxyquinoline or phosphoric acid) it can be left in an open container without too rapid a loss in concentration. Concentration drops off rapidly at first and becomes progressively slower as time goes on, provided no unusual conditions are encountered, and provided further that the heat of decomposition is allowed to dissipate. The drop during the first month in storage is about equal to the drop to be expected for the re-

Contributed by the Power Division and presented at the Annual Meeting, New York, N. Y., December 2-6, 1946, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

mainder of the year. It is roughly 1½ per cent the first month and 3 per cent the first year and very little thereafter, but may be much less.

Provided one's hands are clean, they can be put into a high concentration of H_2O_2 without any immediate sensation except a slight prickling. In less than one hour, however, the hands will look as though whitewash had dried on them. When that coating wears off, the skin will be bleached white. All except a few materials act as catalysts for H_2O_2, so if there is dirt under the fingernails or on the hands, a burn will result. The antidote is water, and the way it acts is to reduce the concentration quickly.

With regard to materials used for handling and storage, iron and copper must be carefully avoided as they are catalysts. Stainless steel, 99.6 per cent pure aluminum, glass, ceramics, and certain synthetics can be used; the most widely used synthetic in Germany being polyvinyl chloride, which looks like rubber in its usual form, although it is also available as a cloth. It is used as a packing material for valve stems and for gaskets but it has one serious deficiency in that it shrinks and hardens with age. It is therefore difficult to keep the systems tight when using it. It is understood that du Pont has a much superior synthetic for the purpose.

PRECAUTIONS IN HANDLING H_2O_2

When the Germans first started handling and storing concentrated H_2O_2, they used many precautions which they later determined from experience to be unnecessary. The requirements which are essential are carefully observed. They have no more fear of handling it than they have for handling gasoline, for example.

In storage the first indication of instability of H_2O_2 is a rise in temperature. If something isn't done about it, the condition becomes progressively worse, finally reaching the danger point when the temperature registers 140 F. At that time, the H_2O_2 is dumped into water. In the early storages, there were cooling coils in the tanks and a sprinkling system above them, but experience showed that they were unnecessary. On noting a rise in temperature, more stabilizer is added.

By far the most fundamental rule in handling concentrated H_2O_2 is to have fresh water instantly available for diluting any spilled H_2O_2. Almost without exception, when concentrated H_2O_2 is spilled, a fire starts. All that is needed to put it out is to reduce the concentration below 78 per cent, provided, of course, that no large amounts of combustibles are in the area. The reason that the fire starts so readily is that there are usually some small amounts of combustibles present, such as grease, paint, wood, or cloth on which the H_2O_2 spills; the dirt on the combustible materials acts as a catalyst; heat of dissociation of the H_2O_2 raises the temperature of the combustibles to their ignition point, and the free O_2 is available to maintain the combustion. A little dilution of the H_2O_2 keeps the heat of dissociation below the autoignition temperature of the combustibles. The Germans kept water in the bilges of the engine rooms of their H_2O_2-driven submarines to reduce the concentration of any spilled H_2O_2.

The men who handle concentrated H_2O_2 wear scrupulously clean polyvinyl-chloride coveralls (which don't look much different from any other kind of coveralls), boots and gloves of the same material, except that the latter are in the form of synthetic rubber.

Laboratory demonstrations of the properties of concentrated H_2O_2 are quite impressive, two in particular. In the first, a clean piece of wood has one end submerged in an open container of H_2O_2. No reaction takes place when it is withdrawn. Another piece of similar wood is rolled on the floor and then dipped in the H_2O_2. It catches fire upon being withdrawn. The dirt it picks up from the floor contains materials which are catalytic. In the other demonstration, a small amount of liquid catalyst (hydrazine hydrate) is put in a large flat pan. Then the chemist stands off as far as possible and throws about 2 oz of H_2O_2 from a beaker into the pan. Only a small part of it actually gets in the pan, but what actually arrives reacts with a loud noise and eruption of sparks. In other words, the decomposition of H_2O_2 in the presence of a catalyst is very violent. In fact, it is a more powerful explosive than TNT, if properly combined with catalyst and fuel; that is, it contains more releasable energy per pound. The material mixes in all proportions with alcohol and with glycerine. It is many times more dangerous to have around than dynamite or TNT, as it is much more unstable.

HYDROGEN-PEROXIDE MANUFACTURE

The usual method of manufacturing H_2O_2 is the hydrolysis of persulphuric acid, but it can be manufactured by any one of several chemical methods. Quite a lot of electrical power and expensive facilities are required for the hydrolysis method so the product is expensive. The cost will come down considerably but it will probably remain high as compared to fuels or gaseous or liquid O_2. Toward the end of the war, Germany had a capacity for manufacturing about 3000 tons a month which was not nearly the amount she wanted. It required the services of about 3000 men to do the manufacturing. Their largest plant was well hidden in the Harz Mountains and was not located by our Intelligence until after the war.

The utmost care is used in the manufacture and cleaning of storage tanks. They are gas-welded and great pains are taken to leave no possibility of H_2O_2 seeping into crevices or under the edges where plates are lapped. Welding rods are carefully selected in order to obtain alloys free of copper. An oxidizing flux is used. After welding the interior of the tank is cleaned and polished, treated with 10 per cent nitric acid, washed, painted (or filled) with 20 per cent solution of caustic soda, washed, treated with 10 per cent nitric-acid solution, washed, then the inside coated with wax.

The wax is composed of paraffin, beeswax, and a synthetic prepared by I. G. Farben. The principal purpose of the wax is to fill any small holes or crevices which may exist. The outside of the tank is heated to melt the wax being applied to the inside. The reason for taking such precautions to fill crevices is that several explosions were attributed to H_2O_2 becoming trapped between plates where they overlapped.

The shape of the tank is influenced by trying to get as small a surface-volume ratio as possible. After the tanks are ready, H_2O_2 is put in and carefully watched for 2 weeks. If undue decomposition is noted, the tank is emptied and the interior again treated. About 10 per cent of the interior is left empty, as a gas space. All piping and valves used for transferring H_2O_2 must be completely flushed with fresh water after each use.

GERMAN USES FOR HYDROGEN PEROXIDE

The Germans used H_2O_2 to launch V-1 bombs, to drive fuel pumps in the V-2 bombs, to drive torpedoes, ME163 and 262 airplanes, and submarines.

For the V-1 and V-2 bombs only the heat of dissociation was used. It was a rather expensive use of energy but was so positive in action that its simplicity and reliability were worth the cost.

Airplanes. The performance of the airplane was astounding. The thrust from the rocket engine corresponded to that of a

3700-hp conventional-type engine, and it weighed about 250 lb. It was not subject to the explosion danger to nearly the extent of the torpedo engine, although the same principle of H_2O_2 in combination with a catalyst and fuel was used. The working fluid was not put through a turbine in this case, however, so power was obtained entirely by jet action. It could be cut on and off instantly.

It was related to the author by a German that a woman made the first test flight in the plane. The fuel supply lasted only a very few minutes but thrust was so great that the plane could not be flown in level flight, with the engine on, for more than a few seconds. It very quickly approached the speed of sound. It could climb to 30,000 ft in 2 min, which made it extremely valuable as an intercepter plane. The first planes, the ones which saw war service, had only a main jet so the engine was either full-out or dead. A later design incorporated a cruising jet, in addition to the main, which increased the time that the engine could be kept on about twentyfold. Its rate of climb and speed in level flight, under cruising jet conditions, were not much better than that of an orthodox gasoline-engined fighter plane, and its radius of action much less; but, until the fuel was exhausted, it had a tremendous reserve of power.

Torpedo Drive. The torpedo drive was somewhat similar to the submarine drive. In the former, a liquid catalyst and fuel combined (Helmann) were used. After 2 or 3 sec, decalene was admitted and the Helmann shut off. Decomposition of H_2O_2 was then accomplished by heat. Temperature in the combustion chamber must remain above 1800 F. The catalyst chamber and combustion chamber were combined. That resulted in a rather dangerous situation, as the arrival of the three liquids had to be accurately co-ordinated. If any was off-time a serious explosion resulted, and our information indicates that about one out of each 100 torpedoes was wrecked that way. The performance characteristics were much superior to those of any other torpedo and they were essentially wakeless.

SUBMARINE PROPULSIVE POWER

In 1943 the Germans realized that our antisubmarine forces had won against the type 7C submarine which they had depended on up to that time. The 7C was fundamentally much like the ones we used in characteristics, except that it was considerably smaller so its speed and endurance were less. It displaced about 700 tons on the surface, had a surface speed of 17 knots and a submerged speed of about 7.5 knots. The Germans were able to change their thinking radically in regard to submarines. They realized that, in order to cope with our antisubmarine forces, they would have to go to a true submarine, instead of a surface ship which could be submerged, and that, to make an attack and then escape, it would be necessary to have high underwater speed. Their first and most important development was the underwater breathing tube or "Schnorchel." They used this against us effectively. It permitted them to make a war patrol without once coming to the surface. It was essentially a pipe, which extended 18 in. or so above the surface, through which they obtained air for the Diesel engines and for ventilation.

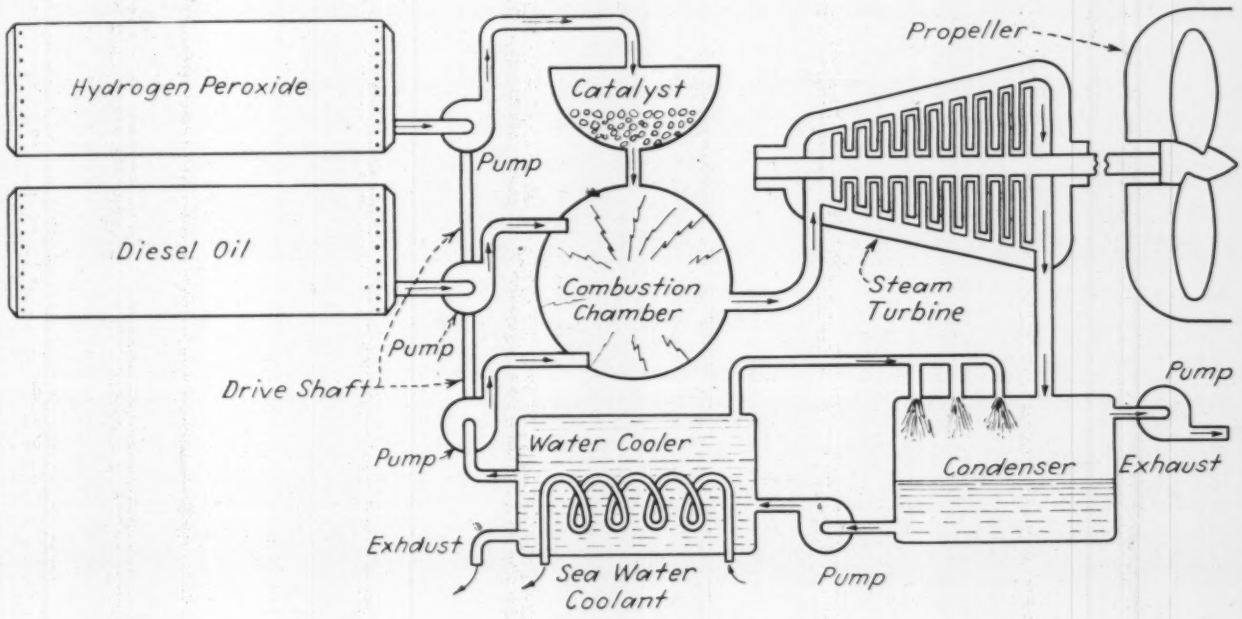


FIG. 1 DIAGRAM OF COMPLETE-CYCLE ENGINE USING HYDROGEN PEROXIDE

Then, in the summer of 1943, they conscripted a group of eminent designers and technicians and assembled them in a little town in the Harz Mountains. They produced the much discussed type 21 boat. It was a completely different submarine. It would have been very effective against us had the Germans not made one fatal error in their design, as they have done so often. Their hydraulic system was so complicated that they couldn't get it to work before the war ended, although they had built about 120 of these boats by that time. Type 21 had a surface displacement of 1600 tons, a surface speed of 15.5 knots and a submerged speed of 16.5 knots for one hour. It obtained its high underwater speed by the use of large battery power and a battery with very thin grids, 0.160 in. thick.

At this time Walter, at Kiel, was able to speed up the ac-

ceptance of his hydrogen-peroxide submarine. He had experimented on the use of hydrogen peroxide since 1935 and had built and operated an 80-ton experimental H_2O_2 submarine before the war. It performed in accordance with his design and realized some 25 to 26 knots submerged speed. During the war, he supervised the design of four school boats, the first of which went into operation in the fall of 1943. They were known as type 17 and performed in accordance with expectations. They were followed by five operational boats, type 17B. These were 380-ton-surface-displacement vessels, surface speed 8.5 knots, submerged speed 25 knots, and had two bow torpedo tubes and two spare torpedoes. They never had a war patrol because there was never enough hydrogen peroxide to permit them to so operate.

The last word in submarine design was to have been the type 26 Walter boat. It was under construction when the war ended. It was to have been of 900 tons surface displacement, 11 knots surface speed, and 24 knots submerged speed. It had 10 torpedo tubes but no spare torpedoes. The hydrogen-peroxide engine (it had only one shaft) was rated at 7500 hp. Our bombing force never permitted the Germans to get the engine assembled.

However, the author collected together all the parts for one engine in the summer of 1945 and shipped them to England, where the engine now is. A schematic diagram of this engine in shown in Fig. 1.

DETAILS OF SUBMARINE H_2O_2 POWER PLANT

There is a so-called triple-feed pump which pumps H_2O_2, Diesel oil, and water. The Ingolin pump parts, piping, and catalyst chamber are stainless steel. The first position on the starting wheel allows only Ingolin to be pumped. Ingolin reaches the catalyst chamber where it sprays on porous porcelain stones on which are fixed calcium, potassium, or sodium permanganate. As mentioned before, the Ingolin breaks up into steam and O_2; 80 per cent steam by volume, at a temperature of about 930 F. From that point on, materials are simple alloy steels. The steam and O_2 mixture go to the combustion chamber. Soon after it reaches that point, the cooling water is allowed to circulate. The water makes two passes through the combustion-chamber water jacket and then sprays into the turbine working fluid. Soon after the cooling water is admitted, decalene is allowed to spray into the combustion chamber.

The temperature in the combustion chamber is above the autoignition point, but an automobile spark plug in the combustion chamber is energized to assure ignition. Danger of explosion exists in the event ignition fails. A proportioning device admits water, Ingolin, and decalene in a ratio of approximately 12 to 9 to 1. The proportioning device gave more trouble than any other item in the machinery plant. The earlier ones were installed on the triple-feed-pump suctions and the later ones on the discharges. There is more hazard connected with those on the discharge side because when the flow of Ingolin is restrained a pressure is imposed upon it and it is churned in the Ingolin pump.

Flame temperature in the combustion chamber is about 4000 F. The water is sprayed into the combustion chamber in an amount to reduce the temperature to the desired degree. The Germans used approximately 1020 F for their turbine working fluid. Working fluid is now about 94 per cent steam by volume and 85 per cent by weight. It goes through what amounts to a conventional steam turbine, operating at 14,000 rpm, and into a contact-type condenser where the steam is condensed.

In the earlier engines, the noncondensing gases were forced overboard by the turbine back pressure but in the engine for the type 26 boat, they were pumped overboard by a Lysholm-type positive-displacement rotary compressor. The spray water for the contact condenser is cooled by circulation through a surface-type heat-transfer unit located outside the pressure hull; sea water is forced through the heat-transfer unit by scoop action.

The machinery installation is not quite as simple as the sketch indicates. The turbine has the same problem of shaft-gland sealing as any other steam turbine. It is water-sealed with a gland leak-off and leak-off condenser. There are three auxiliary lubricating-oil pumps which are used for starting only. When running, lubrication is accomplished by pumps driven from the gears. There is a Diesel engine for surface and schnorchel operation; a main motor and a creeping motor for submerged battery drive. The main motor also serves as a generator while the boat is being driven by Diesel engine or Walter engine. It furnishes power for auxiliaries and for charging batteries. The creeping motor is a high-speed low-power affair which drives the main shaft through multiple V-belts. The main turbine drives through a conventional single-reduction double-helical gear and then through a planetary gear. The Diesel and main motor are on the same shaft and drive only through the planetary gear. The single-reduction gear and turbine can be disconnected by a clutch. The main motor and Diesel or just the Diesel are connected or disconnected by clutches. The main motor, however, always operates, either as a motor or a generator, except when the creeping motor is in use. All gears are disconnected when using the creeping motor.

GERMANS COMPLICATED H_2O_2 MACHINERY UNNECESSARILY

The machinery was subject to many breakdowns, the principal reason being that in Germany a design error, or what might be interpreted by the courts as a design error, was a civil offense. That caused the designers to guard against all damaging casualties to machinery, instead of accepting some hazards for the sake of simplicity. For example, there were five shutdown devices installed to guard the turbine. That resulted in complications which led to frequent malfunctioning of safety devices. The machinery compartment was sealed off when machinery was running but the crew would go in with little hesitation when casualties occurred.

Submarine propulsion was the ideal application for H_2O_2, its value resulting from the fact that using H_2O_2 is a good way to obtain O_2 for combustion when operating submerged. By "a good way" is meant that it had many advantages. It was carried in collapsible polyvinyl-chloride bags outside the pressure hull. The hydrostatic pressure outside kept a positive pressure on the Ingolin pump. Ingolin used from inside the bags was displaced by sea water outside the bags, which compensated for about $^3/_4$ of the weight of Ingolin used, the difference being the difference in the specific gravity of the two liquids. Fresh water obtained by condensing the H_2O in the turbine working fluid could compensate for the difference, in order to maintain neutral buoyancy. Actually it was not done that way but was accomplished by admitting sea water into a compensating tank. Excess fresh water was forced overboard with the CO_2 and other noncondensing gases.

The one big disadvantage to the use of Ingolin is its cost. As indicated before, about 9 times more of it is used than Diesel fuel, and it costs 60 or 80 times as much per pound. Multiply 60 or 80 by 9 and the result is high. As a matter of fact, its cost is near enough to a thousand times greater than fuel oil to use that figure as a rough comparison of costs when using H_2O_2 and oil for producing power.

MECHANICAL APPLICATIONS *of* LATEX-DIP COATINGS

By FRED W. WOERNER

REEVES RUBBER, INC., SAN CLEMENTE, CALIF.

NATURAL-rubber latex is the milky sap or juice secreted by various species of rubber-bearing plants. Nearly all the latex in commercial use is produced in the Far East from a tree which the botanists call Hevea Brasiliensis. This tree is indigenous to the Amazon Valley of South America. The latex, besides containing negatively charged globules of rubber in colloidal suspension, contains a number of serum constituents which are present in small quantities, such as sugars, fatty acids, proteins, natural antioxidants, enzymes, and other organic materials.

With the advent of synthetic rubbers, we have had to broaden our definition of rubber latex to include the artificially produced latices of the synthetic rubbers and rubberlike plastic materials. During the present shortage of natural-rubber latex, caused by the war, these synthetic materials have made a place for themselves from which they will not be dislodged. In many ways they are superior to natural rubber and they have specific properties which can be manufactured to order.

CHARACTERISTICS OF NATURAL- AND SYNTHETIC-RUBBER LATICES

Natural Rubber. Natural-rubber latex is prepared from the sap which flows from a cut in the bark of the rubber tree. Preservatives, usually ammonia, are added to the latex, which is then concentrated from about 40 per cent total solids to about 60 per cent total solids. Up to a concentration of 62 per cent, the latex is very fluid, but as the concentration rises above this point the viscosity increases rapidly. Therefore the latex of commerce is generally of this concentration, 58 to 62 per cent.

Since latex contains about 40 per cent water, and must be kept on the alkaline side of the pH scale, all compounding ingredients must be added in the form of a slurry containing wetting agents, dispersing aids, and stabilizing agents to prevent coagulation of the latex. All compounding ingredients, except those which are soluble in water, must be ground into colloidal dispersions, usually in a ball mill, to prevent settling out of the compounding materials which are added to the latex for the purpose of modifying the properties of the finished latex film. Carbon black and pigments which give high abrasion resistance and reinforcing in normal rubber mixing do not have the same effect in latex mixes. They act more like diluents and fillers. It is not possible to get the same degree or kind of abrasion resistance from a latex-deposited film as is customary with a normal tire tread.

Generally speaking, coatings deposited from natural-rubber latex have high tensile strength, high elongation, good age and weather resistance, a high degree of rubberiness, i.e., high rebound, elasticity, or snap, and excellent compression set. They are very resistant to alcohol, acetone, glycerine, and hydraulic fluids used in the brake systems of automobiles, dilute acids, alkalies, and salt-water systems. They are not resistant to the oils, greases, gasoline, aromatics, lacquer, and paint thinners and solvents.

Contributed by the Rubber and Plastics Division and presented at a meeting of the Aviation Division, Los Angeles, Calif., June 3–5, 1946, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

Neoprene. Neoprene latex is available in several types and a usual concentration of 50 or 59 per cent total solids. Since neoprene is prepared in an emulsion, it is only necessary to use a little care in the preparation and concentration in order to secure a latex with the same inherent properties of the regular grades of neoprene or GR-M. It is handled in much the same way as natural-rubber latex, except for inherent differences required in compounding. The dipping techniques are the same.

Films deposited from neoprene latex have a high tensile, high elongation; extremely good light, weather, and age resistance; a high rebound, elasticity or snap, and good compression set. However, the rebound of neoprene is not quite as good as that of natural rubber. Neoprene coatings are very resistant to alcohol, acetone, water solutions, hydraulic fluids, medium concentrations of nonoxidizing acids, organic fats, and oils. Its resistance to lubricating oils and automotive fuels depends upon the aniline point of the material in question. The film may exhibit a slight tendency to swell in a high-aniline-point oil or fuel and be entirely unsuitable in a low-aniline-point material as was demonstrated by Powers and Billmeyer.[1] Neoprene films would be unsuitable for use with the aromatic solvents, chlorinated solvents, and most of the organic paint thinners and lacquer solvents.

Buna N. There are a number of Buna N latices available. The variation on the acrylonitrile content will have a bearing upon the physical properties of the deposited film. The commercially available latices have the approximate percentage of 26, 35, and 42 per cent acrylonitrile content. The resistance to aromatic fuels and low-aniline-point oils is in the order mentioned, namely, the 26 per cent is least resistant, while the 42 per cent acrylonitrile material is most resistant. Buna N coatings have a good resistance to alcohol, lubricating oils, automotive fuels (again depending upon the aromatic content or the aniline point), dilute acids, and alkalies. The compression set is good. Their resistance to light is poor; however, this can be improved by proper compounding. These materials are not suitable for use with aromatics, chlorinated solvents, or lacquer solvents.

Buna N films have a very low tensile strength and low elongation until compounded with suitable ingredients, particularly carbon black; therefore one should not expect to use colorless films of the Buna N's if the best of physical properties are desired. Their compression set is good. Their rebound or snap is only fair, hence for certain applications of vibration damping they should prove superior to natural rubber because they have a tendency to absorb rather than transmit the shock.

GR-S. Our wartime general-purpose synthetic rubber is available in latex form. GR-S latex is being successfully used for the deposition of coatings. Its properties are similar to those of natural rubber for the most part, except that, like the Buna N's, a reinforcing filler is required to bring out its best properties. Films of pure-gum-type compounds have low ten-

[1] "Swelling of Synthetic Rubber in Mineral Oils," by P. O. Powers and B. R. Billmeyer, *Industrial and Engineering Chemistry*, vol. 37, January, 1945, pp. 64–67.

sile strength and elongation. The tear resistance is rather poor until compounded with carbon black or similar filler. The compression set is good, but the rebound or snap suffers when compared with natural rubber or neoprene. This material is not oil-resistant. Its resistance to solvents is of approximately the same order as for natural rubber. Its resistance to weathering and aging is good.

Thiokol. There are a number of polysulphide rubber latices available which are specialty materials. They are known as the Thiokols. Films deposited from some of them are extremely resistant to solvents, even being resistant to the aromatics and chlorinated solvents. They are extremely resistant to aging and light and are available from soft to hard materials, but since they are quite thermoplastic their compression set is rather poor. Special techniques are required in their use.

The indicated uses for this type of material are as slushing compounds for the sealing of integral tanks for aircraft; as tank linings, where corrosion is a problem, gasoline-proofing, and fabrics. Enough work has been done along these lines to indicate that there are possibilities in the fields indicated.

Water Dispersions of Natural Rubber and Reclaim. Water dispersions of natural rubber and reclaim are available. These are manufactured usually by milling into the rubber, or reclaim, the compounding ingredients desired with a material which is quite readily wetted by water. The rubber or reclaim is then macerated in a closed vessel with water, dispersing agents, and colloidal stabilizers. The application of heat aids in the disintegration of the rubber into colloidal particles suspended in water. These water dispersions can then be used as normal latex or as additives to normal latex. However, the physical properties of this type of water dispersion are not as good as the original material. The intense maceration required causes a partial deterioration of the material, which is noticeable in reduced tensile strength and greater softness.

Water Dispersions of Plastics and Resins. Recently there have appeared on the market water dispersions, sometimes called latices, of various plastics and resins. They are generally used as additives with the regular latices of natural or synthetic rubber. Vinyl chloride has found wide acceptance for use with the latices of Buna N due to its high degree of compatibility. It is also compatible with neoprene and GR-S. The water dispersions of these plastic rubberlike materials and resins are often used as coating materials for fabrics without the addition of rubber.

Special Types of Latices. In 1925 a patent[2] was issued to Schidrowitz, in the United States, for the prevulcanization of latex which could then be used as normal latex for the manufacture of latex-dipped articles without further vulcanization. In practice, the state of vulcanization is generally low. If a tightly vulcanized article is desired, further vulcanization is required, but for most purposes the original vulcanization is sufficient.

Considerable interest has been shown recently in reversed-phase latices, which are of two general types as follows: (1) The latex is dispersed in a solvent so that the solvent becomes the continuous phase and the water present the dispersed phase. The viscosity of the solvent-dispersed material is much higher for the total solids content than the latex itself. This type of material is used for adhesives and laminating cements, particularly for paper, fabrics, leather, and other porous materials. (2) The other type is one in which the electrical charge is reversed on the latex globules; in other words, the latex now is acid-stable which permits the addition of certain modifying agents which cannot conveniently be added without coagulation of the ammonia-stable latex. The latex produced from a South and Central American tree, known as Castilloa Elastica, is acid-stable. Only a few samples have been sent into the United States, and then only for laboratory purposes, and at the present time it is only a scientific curiosity.

Latex coatings can be supplied that range from a soft rubbery material with low Shore durometer, low modulus, and high elongation, through high durometer, high modulus, and on into the true hard rubbers. These properties depend upon the type of compounding employed and the selection and addition of modifying agents. The rubber chemist should judge the type or base material used and compounding employed.

POROUS ARTICLES

Films and molded articles can be made which are microporous. They are manufactured by vulcanization of the wet article, the entrapped moisture forming the pores as the material dries out. The manufactured products of microporous hard rubber are usually thin and as such as are suitable for diaphragms used as separators in electrical storage batteries.[3]

"It should be understood that to yield the microporous material, the wet rubber coagulum should not collapse or shrink in drying; therefore the final product should approximate hard rubber or vulcanite. A soft rubber obtained similarly is not ordinarily microporous after drying, though the wet vulcanization gives it properties different from those of latex rubber vulcanized after drying.

"The pores remaining in the hard rubber when a wet rubber coagulum is vulcanized without escape of the entrained water average approximately 0.0004 mm in diameter. Their size and number can be governed by controlling the strength of the original gel and the proportion of water included in it, i.e., by the composition of the dispersion before setting. Microporous hard rubber has been put to a number of uses, but it is chiefly of importance as a diaphragm in secondary batteries and electrolytic processes, for which its low electrical resistance and high chemical stability are definite advantages."

The methods for producing porous molded articles with pores visible to the naked eye fall into two categories, that is, those that depend upon the addition of gas-forming agents for the development of the porosity, and those in which the gas is introduced mechanically. Due to the strength of the coagulum formed from latex, it is difficult to secure a uniform cell by the addition of gas-forming agents. The sponge thus formed has a crust and a variable density.

The method almost universally used at the present is the so-called latex foam or froth. The latex foam or froth is conveniently produced by the use of a beater similar to the giant egg beater which whips the compound, to which a frothing agent has been added, into a mass resembling whipped cream. Shortly before completion of the mix a delayed-action coagulant is added which then causes the mix to coagulate after it has been poured into the mold. The coagulum retains the shape of the mold and does not change dimensions as it dries out. The article is vulcanized in hot water or in a hot-air oven. The amount of air introduced into the mixture is indicated by the height to which frothing is allowed to take place, and accurately decides the density of the final product.

Sponge rubber manufactured by this method has many important properties and advantages. The porous structure is extremely uniform; there is no crust or skin; the surface consists merely of a series of flattened bubbles; and the material is composed of a system of uniform interconnected small cells. It has great durability and lends itself to the manufacture of

[2] U. S. Patent No. 1,443,149, Jan. 23, 1925.

[3] "Chemistry and Technology of Rubber," edited by C. C. Davis and J. T. Blake, Reinhold Publishing Corporation, New York, N. Y., American Chemical Society Monograph No. 74, 1937; "Industrial Uses of Latex," by D. F. Twiss, E. A. Murphy, E. W. Madge, and G. W. Trobridge, chapt. 17, pp. 629–630.

complicated shapes. Sponge manufactured by this process has many desirable mechanical features. It is self-ventilating, antiseptic, durable, and can be made in varying degrees of softness, including hard rubber. It is being used extensively for household furniture, upholstery of all kinds, hospital mattresses and shock pads inside of tanks. The hard-rubber sponges are very light, and take the place of cork as insulation; as buoyant media when enclosed in a protective wrapper; and sandwiches between lightweight high-load-carrying laminates.

LATEX-DIPPED COATINGS

The direct applications of latex-dipped coatings are almost innumerable. It is applicable whenever a relatively thin coating is required. Coatings up to $^3/_{16}$ in. thick can be manufactured. Usually, the application of coatings over $^1/_8$ in. thick is uneconomical. Then, also, there is a shrinkage due to the loss of about 40 per cent of its volume of water. As a consequence of the methods of manufacture, there are variations in the thickness of the films. However, it is the only practical way of depositing thin coatings on various materials, such as metals, paper, wood, and plastics, or the manufacture of thin or complicated shapes of molded-rubber parts. Usually the cost is much less than for an article molded by the conventional methods in a mold placed in a steam-heated hydraulic press. The forms can be fabricated out of low-tensile- low-compression-strength materials which can be cast or fabricated from easily worked materials. Aluminum or porcelain forms are best, although wood and even plaster can be used.

The dipping conditions can be varied to deposit films of only 0.001 in. or as much as 0.025 in. per dip. Heavy coatings require repeated dips. The present practice is based upon the use of coagulant solutions. There are several methods of using the coagulant, but the most common is as follows: The form is dipped into the compounded latex which is slowly agitated to keep the heavier components from settling out and to prevent a skin formation on the surface of the dip tank by evaporation. The form is withdrawn slowly to prevent rippling and bubble formation. The withdrawn form is then dipped in the coagulant solution, which sets the film on the form. The coagulated film is allowed to partially dry, then is redipped. The entrapped coagulant helps build up a heavier film than would be possible without the coagulant by coagulating the latex immediately adjacent to the form, thus building up a heavier deposit. After the required number of dips the coagulum is washed on the form and then dried before vulcanization.

Some of the products manufactured are seamless gloves, bathing caps, sports grips, tobacco pouches, ice bags, face pieces for gas masks, dental dams, balloons, druggist sundries, plasma tubing, and many others.

The formation of rubber thread may be regarded as a special dipping process. The compounded latex flows under slight pressure through an orifice directly into a suitable coagulant bath. The extruded coagulum is then picked up by conveyers where it can be washed, dried, and even vulcanized continuously. The thread thus obtained is circular in cross section, with a smooth surface. The diameter may be as small as $^1/_{125}$ in.; in fact, a pound spool of thread may carry as much as ten miles of thread.

The pure-gum plasma tubing made during the war was formed around a rawhide or rubber core from which it was stripped after vulcanization. The core or form was led automatically from one latex bath into the coagulant, then into another latex bath, and so on until the desired thickness of wall had been deposited. After the last coagulant bath the deposited tube was washed and vulcanized.

A rather large quantity of surgical tubing was manufactured without the use of coagulant—the anode process. The wall thickness was built up by repeated dips and drying with heat sufficient to set the film for the next dip. This process eliminated the washing required when using a coagulant. The tensile strength of pure-gum tubing or rubber thread may be as high as 6000 psi.

Occasionally it is desirable to improve the appearance of a product by giving the article a velvety finish. Such a finish can be secured by dipping the article in latex and then blowing onto the wet surface of the freshly dipped article a suitable flocking material with the aid of an air gun, somewhat similar to that used for spray-painting. A proportion of the flock is then held or bonded to the surface of the article by the latex, which can then be vulcanized later if desired. The type of flocking material used and the length of the individual fibers determine the appearance of the finished product. A flock surface can be applied to metal, ceramics, wood, leather, fabric, rubber, and many other materials.

MISCELLANEOUS USES FOR LATEX

A few years ago the field of temporary coatings to protect materials while in storage or transit received a great impetus. The part to be protected, such as bright hardware on automobiles, etc., was either dipped or sprayed with the latex compound and, while still wet, was covered with paper which then gave a nonscuffing surface. When the article was ready for use or display, the paper was stripped off, leaving a clean bright surface. If a bit of the latex adhered to the article, it could be rubbed off very easily with a cloth or whatever other polishing materials were available. The latex formed a film entirely around the part, and was partially absorbed into the paper which made it more impervious than either the latex or paper alone by filling the pores of the paper.

A large usage of latex has developed in the manufacture of adhesives and cements. They can be applied by brushing, or mechanically by roller-coating. Rarely are they applied by dipping. Some of the large applications are laminating of paper and paperlike materials, cementing transparent windows in paper containers, shoe cements, crimp-joint sealing compounds for tin cans, sealant rings in the lids of home-canning jars, final sealant dip over containers, and so on.

One particular patented application in the food-packaging field deserves mention here. A thin-walled sterile latex bag is placed in a device which holds the bag open while a meat product, section of beef, fowl, or a similar food product is inserted. The bag is then closed and the air evacuated, thereby causing the bag to collapse and hug the food product to be preserved, very closely. This thin film of odorless rubber prevents dehydration of the surface, so-called freezer burn, of the meat product in cold storage.

Considerable demand has developed for latex-coated fabrics or proofing. Except for specialized uses, the resins and plastics have taken over the field of proofing or rain wear, tents, awnings, and the like. Latex is used in the manufacture of high-quality fabric-backed hospital sheeting, latex-dipped fabric gloves, water- and oil-proofing of cords and ropes, oil-well survey cable, and the water- and oil-proofing of fabrics and mesh bags. One interesting application is that of the mesh laundry bag. These mesh bags have a very short life because of their constant subjection to moisture and abrasion. By coating the meshes with a thin film of latex, generally by dipping the cords before weaving, the life is increased as much as 10 to 20 times that of the untreated bag. Cords are "gum-dipped" before building into rubber tires, belts, and rubber hose to insure the maximum adhesion between the rubber and the cord-reinforcing body. The low viscosity of the latex permits penetration of the cords by the liquid which has a tendency to deposit a thin film of rubber around the individual fibers,

thereby providing an interlocking film, or rivet, giving an apparent better rubber-to-fabric adhesion.

COATING LATEX ON METALS—SPECIAL APPLICATIONS

One of the largest fields for the application of latex-dipped coatings is the coating of various metal parts. The purpose of these latex-deposited coatings may be as varied as the products of one industry varies from those of another. It may be necessary to protect the metal part against moisture, salt spray, acids or alkalies, corrosive fumes, or contamination of the materials being processed, which might dissolve minute quantities of the metal constituents of the processing equipment, or the prevention of catalytic action, initiated by the metals used in the manufacturing equipment. The latex coating may be used for electrical insulation, or as a separator for two dissimilar metals to prevent galvanic action. A latex film may serve as the sealing face against gases and liquids in valves and diaphragms. The appearance of an article is often improved by latex coating. It may be used as a chaffing strip, as a "sound deadener" to cut down noise in handling, and as a shock absorbent material to prevent breakage of bottles. Metal parts, subject to abrasion by particles impinging on the metal surfaces, can be protected effectively by latex coating.

One of the important fields for latex coatings is the lining of tanks, pipes, and various containers used in the handling or transportation of liquids. Ordinary steel containers can be coated so that they may be used for the handling of acids, alkalies, and many kinds of corrosive liquids. Hard-rubber containers are brittle and subject to breakage, whereas a steel container, latex-coated, is very durable. Pipes may be coated either inside or outside, or both sides as desired. It is common practice to coat the inside of pumps handling corrosive liquids, the blades of fans, grilles, or dampers used in corrosive atmospheres. Plating tanks are sometimes lined with latex-deposited linings, and the racks and shields are protected by films of rubber deposited from latex. Latex-coated screens, strainers, and baskets are usable in corrosive media. A considerable quantity of chemical equipment could profitably be latex-lined to prevent contamination of the chemicals being manufactured.

During the recent war a considerable quantity of metal strips were used as chaffing strips on aircraft cowling. Rubber was bonded to one face of these chaffing strips. Generally they were made of molded rubber or by cementing sheet rubber, which was often unsatisfactory. The same result could be accomplished by latex-dipping. The face of the strip would be painted with the bonding cement, while the back of the strip would be masked so that the latex could be stripped off leaving one face of the strip covered, while the previously masked back of the strip would be bare. After vulcanization, the latex coating becomes permanently bonded to the metal strip.

Screens, racks, trays, and similar articles can be coated with a rubber film deposited from latex. The coating may be colored, thereby adding to the sales appeal. As mentioned before, an extremely thin film only a few thousandths of an inch thick may be deposited, or a sufficiently heavy coat to fill in all the holes or openings in a screen. The coating of live resilient rubber on trays and dish racks reduces noise and breakage. For instance, the ordinary milkman's tray for handling milk bottles becomes practically noiseless and soon pays for itself in reduced breakage. Bottle and beaker racks, and sterilizing trays, for use in hospitals and laboratories, might profitably be latex-coated.

Valves, pipe lines, pumps, orifices, nozzles, etc., handling gases or liquids with suspended abrasive solids, such as sand, last much longer when coated with resilient rubber. The particles of abrasive materials passing over the soft rubber surfaces do not abrade the rubber as readily as the metal surfaces. The rubber surface yields before the impact of the abrasive, and instead of being pitted or scratched, it presents an unscarred surface as soon as the impact energy has been expended, and the surface returns to its original position. By the use of latex-dipped coatings the life of sizing screens used for grading coal, sand, or gravel has been materially increased. Abrasive sifting screens have an extremely short life unless coated with rubber. Valve seats coated with rubber do not require perfectly machined surfaces in order to function. The rubber, as it is compressed, flows into whatever low spots or depressions there may be, thereby forming a perfect seal.

There are a few specialized applications which deserve mention. One is the manufacture of weather balloons for the carrying of radio reporting instruments into the stratosphere. Obviously, in order to get the size of balloon required, an extremely large dip tank would be required, but a little ingenuity produced the following method: A fluted form about 24 in. long was dipped into the latex. When the required wall thickness was secured, the balloon was dried, but before vulcanization the balloon was stripped from its form which was so constructed that the balloon opened up to a perfect sphere when blown up with air to about 6 ft diam, in which condition it was cured in a hot-air oven. After vulcanization, the balloon had a diameter of 6 ft at zero pressure or in the unstressed condition. The balloon was capable of being distended to a diameter of 33 ft. This same method may well be used in the formation of certain parts by blowing out against forms to give definite shapes and then curing.

Another possibility is the combination of rigid materials such as plastic ducts and tubes with latex-deposited flexible joints or coupling ends to give definite seals and provide ease of installation. Flexible air ducts and couplings, especially the accordion type, are naturals for latex-dipping. Beads can be applied to edges of these couplings by laying an extruded section around the bead area upon a dipped form and then dipping over the extruded bead.

In the manufacture of latex-dipped articles, a few precautions are necessary. Sharp edges are to be avoided because the latex coagulum, as it dries, shrinks and the film over the sharp edges is thinner than elsewhere. Also, sharp angles are cause for bridging therefore wherever possible, all sharp edges or angles should be avoided by using a substantial radius.

CONCLUSION

The properties of latex-deposited coatings vary from soft resilient rubber to hard rubber or vulcanite, depending upon the type of latex used, and the compounding employed. The coatings may be oil-resistant, weather-resistant, light-resistant, unaffected by medium concentrations of acids or alkalies. The film thickness may be as little as a few thousandths of an inch or can be as much as $^3/_{16}$ in.

The applications of latex-dipped goods include such items as gloves, hot-water bottles, ice bags, druggist sundries, dental dams, balloons, gas-mask face pieces, sponge or latex froth, microporous articles, rubber thread, and plasma tubing, temporary coatings, adhesives, and sealing compounds. The proofing of fabrics, coating cords, and ropes for protection against moisture, coating laundry bags, and "gum-dipping" cords for tires, belts, and hose are some of the important uses of latex. The field of latex-coating metals to protect against chemicals, to provide abrasion resistance, electrical resistance, to reduce noise and breakage has scarcely been touched.

The next few years should see many new ideas in the mechanical application of latex-dip coatings. In the past latex has been used primarily in the manufacture of novelties, druggist sundries, and thin-walled goods. Here is one technique that the industrial designer has largely neglected, but as it becomes familiar it is rapidly being applied in a wider field.

Flexible ORGANIC ADHESIVES *as* STRUCTURAL ELEMENTS

By D. L. LOUGHBOROUGH and F. D. SNYDER

PHYSICAL RESEARCH LABORATORY, B. F. GOODRICH COMPANY, AKRON, OHIO

General. Recently many organic adhesives have been placed on the market which are capable of forming sufficiently strong bonds to be used in structural parts. The interest arose primarily as a result of special needs of the aviation industry for war production. At least seven different materials have been offered,[1] each one of which has advantages, either in method of application or in properties of the "cured" bond. (A cured bond usually refers to the joint made by an adhesive which has undergone a reaction, caused by some means such as heat, pressure, or a chemical catalyst.) The evaluation can only be made by actual service; the laboratory data should be used as a guide.

It is proposed to submit the available data on one of these structural adhesives, Plastilock 500. This bonding material is an alcohol solution of synthetic organic resins. The cured bond is unaffected by temperatures from —60 F to +160 F, but weakens at temperatures above +160 F.

Advantages of a Cemented Joint. The variety of methods for joining aluminum-alloy products has recently been described by Hartmann, Hoglund, and Miller (1).[2] They discuss riveting, welding, brazing, soldering, and resin-bonding. Each of these methods has special advantages and disadvantages which must be considered by the designer. The properties of a cemented joint will be discussed, the advantages being as follows:

1 A smooth, clean, continuous joint is obtained.

2 There are no local stress concentrations to encourage buckling.

3 The method is applicable to materials such as wood, paper, plastics, which cannot be fastened by other methods.

4 Easy production methods are possible.

5 Airtight and liquidtight joints are obtained.

The disadvantages which must be considered are as follows:

1 Production tooling is different from methods now in common use.

2 No method is known for determining the perfection of a finished joint. Process control is required.

3 With very thin flexible materials, such as aluminum foil, the bonded materials can be easily bent. Applying a load to such a joint results in the stress being concentrated along one line in the cement and hence failure at low applied loads. This property, known as strip resistance, is generally poor in cemented joints.

Relative Strengths of Various Joining Methods. The strength of a joint may be given by its efficiency. This efficiency is the ratio between the stress in the metal outside the bond when the joint fails and the ultimate stress of the metal. The maximum strength of any type of joint will depend on such factors as the overlap of the joint and the thickness of the materials being joined. From references (3, 4, 5), it is possible to make an estimate of the relative efficiencies of various joining techniques. The overlap given in the third column of Table 1 is the lowest

TABLE 1 COMPARISON OF JOINING TECHNIQUES

Method of joining	Maximum possible efficiency, per cent	Minimum overlap, in.
Riveting	80	$1\frac{1}{2}$
Spot welding	87–93	$1\frac{1}{2}$
Cementing	90	$\frac{3}{4}$

which can be used to obtain the results listed in the second column. These efficiencies apply only to single simple joints in tension. In complicated structures the joint strength will be lower because of stress concentrations at the joint. For instance, a sheet-stringer combination under end load wrinkles at low loads because of the stresses at rivet heads. In such a service continuous joints have proved advantageous.

PHYSICAL PROPERTIES OF PLASTILOCK 500 JOINTS

Summary of Properties. The measured properties depend upon the temperature of the cure, the temperature of the test, the metal thickness, the extent of the overlap, the shape of the metal at the joint, the thickness of the bonding medium, and the fit of the pieces to be joined. The effect of these factors will be examined in detail later. In Table 2 are presented some typical data on joints made with 24S-T Alclad with $\frac{1}{2}$-in. overlap. These tests were made on 0.032-in-thick metal, with a bonded area $\frac{1}{2} \times \frac{1}{2}$ in. The samples were pulled at 1 ipm.

TABLE 2 PHYSICAL PROPERTIES OF PLASTILOCK 500

	Strength at		
	—60 F	+70 F	+160 F
Shear strength, psi	3000	3300	3100
Tensile strength, psi	...	8000	...
Impact strength, ft-lb per sq in.	13	14	...
Stripping load	Low	Low	Low
Fatigue (maximum stress 1000 psi)	...	$>10^8$ cycles	...

STABILITY IN PRESENCE OF SOLVENTS

Effect of immersion in water	Metal and plastic bonds; no loss in 60 days Wood bonds; see discussion Glass bonds; destroyed in a few hours
Effect of salt-water spray	No effect on shear strength after 60 days on 24S-T alloy
Effect of immersion in:	
100-octane gasoline	No loss in strength after 60 days on metals
40 per cent aromatic gasoline	10 per cent loss in strength after 60 days on metals
Alcohol and ketones	Bond destroyed by this type of solvent

The immersion tests were run by placing the joined test pieces in the solvent mentioned and making shear-strength

[1] Cycleweld, Redux, Plastilock 500, Reanite, T-46, Metlbond, Pliobond.

[2] Numbers in parentheses refer to the Bibliography at the end of the paper.

Contributed by the Rubber and Plastics Division and presented at the Semi-Annual Meeting, Detroit, Mich., June 17–20, 1946, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

determinations weekly. Tests were discontinued at the end of 60 days. The joined area was chosen to be $1/2$ in. $\times$ $1/2$ in. to give a large exposed edge length compared to joined surface.

Table 2 shows at once that the material is slightly heat-sensitive. By adjustment of the ingredients it is possible to change this sensitivity. Fig. 1 shows the variation in shear strength with temperature for Plastilock 500 and three modifications not as yet commercially available, in a joint with $1/2$-in. overlap, on 0.064 in., as received 24S-T Alclad. The tensile strength of the cement is high, giving 8800 psi on steel and over 8000 psi on 24S-T. When pulled in tension, stress concentrations are at a minimum and the joint exhibits its full strength.

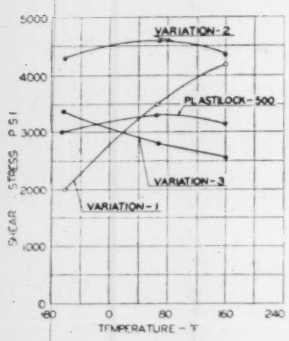


FIG. 1

The absolute value of the strength, in tension or shear, depends upon joint geometry. The transfer of load from one section of metal to the other causes a moment imposing both shear and tension on the bond (2, 3). The strength will not increase in direct proportion to the joint overlap. In addition, the elongation of the metal as the load is applied causes a stress concentration in the cement (6). This second situation can be relieved by the use of a beveled joint. By keeping the combined thickness of metal constant across the overlap de Bruyne (6) has shown that the joint strength can be made to increase in strength in direct proportion to the overlap. Table 3 gives similar data on Plastilock 500.

In the joint with beveled overlap, two 0.125-in-thick $\times$ 1-in-wide pieces of alloy were milled so that the thickness varied from nearly zero at the end to the full $1/8$ in. at a point $1\,1/2$ in. from the end. These pieces were then cemented together, with the adhesive on the straight surfaces. When tested, the elongation in the two metal sections was nearly equal, decreasing the stress concentrations and giving much higher strength.

The stripping load is not given in Table 2 because no satisfactory test is known for this type of joint. It is, however, valuable to keep in mind that this and most other organic adhesives are poor in this regard and should be protected by terminal rivets or similar type of fastening at the end of joints to prevent tears from starting.

Tests of the fatigue resistance of Plastilock 500 joints were conducted on the R. R. Moore fatigue machine, using a rotating-beam specimen in which the stress is reversed completely each cycle. With a maximum stress of 1000 psi samples have not failed in 10^8 cycles. At higher stresses our results are incomplete. Statically a bond will hold 2000 psi indefinitely. Again, the life at higher load has not been determined in this laboratory.

Table 2 gives the results on the solvent resistance in sufficient detail to need no further comment. The tests in salt water were interesting. On the $1/2$-in. $\times$ $1/2$-in. sample using 24S-T Alclad, the bond area was reduced by 50 per cent due to metal corrosion between the alloy and Alclad coating. On a similar sample from which the Alclad had been removed there was no measurable loss in strength at the end of 60 days. Evidently the Plastilock 500 is a good protective coat for aluminum alloy.

Bonds to Other Than Aluminum. One of the principal advantages of an organic adhesive is that it can form good bonds to materials such as wood, plastic, rubber, etc. The strength of the bond depends upon the nature of the solid being bonded.

TABLE 3 EFFECT OF JOINT GEOMETRY

Overlap, in.	Metal thickness, in.	Shear strength, psi — Plain overlap	Shear strength, psi — Beveled overlap
$1/4$	0.064	4100	...
$1/2$	0.064	3300	...
$1\,1/2$	0.064	2450	...
$1\,1/2$	0.125	...	4800

TABLE 4 SHEAR STRENGTH OF PLASTILOCK 500 BONDS; DIFFERENT BONDED MATERIALS

Solids	Shear strength (room temp), psi
Spring steel	4800
Magnesium alloy AMC 525-H (sodium-dichromate-treated)	3500
24S-T Alclad	3300
24S-T alloy	3300
Tungsten	3100
Structural steel	3000
Chromium-plated steel	3000
Silver	2800
Stainless steel	1700
Anodized aluminum	1500
Everdur (over 95 per cent copper)	1000
Brass	875
Zinc	600
Magnesium alloy AMC 525-H (untreated)	600

Soft wood, Monel metal, Tantalum, Tin, Lead, Phenolic resin, Urea formaldehyde resin, Formica, Fiberboard — Bonded material failed in tension or shear; therefore the bond was stronger than the test material, which was 0.032 in. or greater in thickness

Table 4 gives the measured shear strength for a number of different materials, in order of decreasing strength.

The high value for spring steel is notable. It is also of value to note that the treated magnesium can be joined by a strong bond, while the untreated material is adhered to poorly. The low adhesion to zinc, brass, and copper alloys should be observed.

The evaluation of Plastilock 500 as a wood adhesive followed Army and Navy specification AN-NN-P-511b and AN-G-8. When tested dry, there was 100 per cent wood failure at 570 lb. After 48 hr in cold water, tested wet, the failure was in the wood at 464 lb, after 3 hr in boiling water the strength had fallen to 244 lb, an adhesive failure. On drying, the bond strength again reaches its high dry value. Thus the bond formed is extremely good but the resistance to water is poorer than some of the best wood glues available. The temperature required is too high and the time required to form a joint too long to make Plastilock 500 a good commercial plywood glue but it will find many uses for forming special types of bonds involving wood.

METHODS OF APPLICATION OF PLASTILOCK 500

General. To secure such high physical strength from organic adhesives some care must be taken in forming the bond.

Cleanliness of Metal. Bonds are strongest to smooth unscarred surfaces. Experience has shown that a buffed or blasted surface is of no advantage and should be avoided. Any good chemical cleaning and degreasing process is satisfactory. No particular care is required to protect the cement from dust or other fine dirt, though particles with a diameter comparable to the bond thickness must be avoided in the cement.

Applying Plastilock 500. This adhesive is most satisfactory when applied by brushing, although dipping and spraying techniques have been used. In brushing, the cement should be allowed to flow on, without attempt to brush it out. Two coats should be used on each surface to be joined, allowing each coat to dry at least 1 hr at room temperature; this time can be reduced by the use of higher temperatures. After drying, the film should be fairly hard, only slightly tacky. Longer

TABLE 5 EFFECT OF PREHEAT, CURING TEMPERATURE, AND TIME ON BOND STRENGTH

Preheat time, min	Curing time, min	Preheat and curing temperature, deg F	Shear strength, room temp; 24S-T Alclad, psi
30	45	250	1620
25	30	280	1920
20	25	300	2175
13	18	325	2360
10	12	350	3300

TABLE 6 EFFECT OF CURING PRESSURE ON BOND STRENGTH

24S-T Alclad sheet curing pressure, psi	Room-temperature shear strength, psi
5	1610
10	1710
25	2835
50	3180
100	3300

drying times are not injurious. The presence of small bubbles in the cement after drying is normal; these disappear later.

Preheating. In order to remove all solvent completely, and to start curing, it is desirable to heat the cement at an elevated temperature. This may be done either with the parts assembled but no pressure applied, or with the parts separated entirely. The time and temperature suggested for this operation are given in Table 5.

Curing Time and Temperature. Following the preheat, the joint is formed under heat and pressure. By using the correct amount of accelerator a bond can be formed at most temperatures in any predetermined time. Such matters as shelf life, ease of handling the cement, etc., usually dictate the commercial considerations. With a fixed amount of accelerator a bond can be formed at any temperature, providing enough time is allowed for bond formation. As a general statement, the bonds which are cured at high temperature for short times give better adhesions. For a fixed formulation the strength decreases as the temperature of cure decreases. Recommended time and temperatures, with resulting strengths, are given in Table 5.

Pressure. The bond can only be formed when the two metal surfaces are brought into reasonably close contact. McBain and co-workers (7–14) have studied the adhesive properties of pure chemicals and have shown that in specific adhesion the strength of the bond rises rapidly with decreasing film thickness when the surfaces fit. A good bonding job can be expected if the two surfaces to be joined are good mates. Under such conditions only light bonding pressures are required. The effect of pressure on the bond strength of two as-received sheets of 24S-T Alclad is given in Table 6.

At extremely low pressures the bond formed will not be continuous, resulting in low strength. At pressures of from 50 to 100 psi, the bond becomes complete, resulting in maximum strength. With these pressures the cement layer will be found to have a thickness of about 0.005 in. Further increase in pressure during cure squeezes out the cement excessively, decreasing the film thickness. Since the cement must stand considerable strain because of metal elongation (6), this decrease is not desirable. Extremely close control of film thickness is not necessary with Plastilock 500.

THEORY OF ADHESION

It is agreed among those who have studied the field of metal-to-metal cementing that the bond is of a specific nature involving either primary or secondary valence forces. However, several interesting features have been observed. Table 7 gives the relation between the adhesion and the spacing of the atoms in metallic crystals. These metals are arranged in the approximate order of decreasing adhesion to Plastilock 500.

The maximum atomic spacing is the largest distance between the atoms in the crystal. In the face-centered cubic structure this spacing is equal to the lattice constant of the crystal. In the body-centered cubic, the spacing is $\sqrt{2}$ times the lattice constant. In the close-packed hexagonal structure the spacing may be either of the lattice constants. It will be observed that metals with spacings over 4 Å give good adhesion, while those under 4 Å are poor. The measured identity period of the adhesive is 4.53 A.

TABLE 7 EFFECT OF ATOMIC SPACING ON ADHESION

Metal	Maximum atomic spacing, Å
Spring steel	4.04
Magnesium alloy (sodium-dichromate-treated)	3.20 or 5.20
Aluminum alloy 24S-T	4.04
Tungsten	4.47
Chromium	4.06
Structural steel	4.04
Silver	4.07
Stainless steel	3.63
Everdur	3.61
Brass	3.61
Zinc	2.66

The adhesion obtained also depends upon the type of oxide present. For example, anodized aluminum gives very poor adhesion. This may be due either to a change in the crystal structure or to the type of oxide surface. This problem becomes very complex because of the large number of different oxides which may exist on the same metal.

CONCLUSIONS

The cement described forms a strong, thermally stable, chemically resistant bond between many different materials. Since experience has shown that the properties can be varied over wide ranges, the comments of users of the material will be helpful in future formulations. It is quite clear that the theory of adhesion is poorly understood and should furnish excellent material for fundamental research work of the highest type.

BIBLIOGRAPHY

1 "Methods of Joining Aluminum-Alloy Products," by E. C. Hartmann, G. O. Hoglund, and M. A. Miller, Trans. A.S.M.E., vol. 67, 1945, pp. 1–21.

2 "The Stresses in Cemented Joints," by M. Goland and E. Reissner, *Journal of Applied Mechanics*, Trans. A.S.M.E., vol. 66, 1944, p. A-17.

3 "Rational Design of Fastenings," by E. S. Jenkins, *S.A.E. Journal*, vol. 52, 1944, pp. 421–429.

4 "Tension Joints in Aircraft Structures," by C. H. Holleman, *Journal of the Aeronautical Sciences*, vol. 10, 1943, pp. 302 and 310.

5 "Spot-Weld Joint Efficiency for Aluminum Alloys," by C. W. Steward, *Welding Journal*, vol. 22, 1943, Welding Research Supplement, pp. 528s–532s.

6 "The Strength of Glued Sheet Metal," by N. A. de Bruyne, *Iron Age*, vol. 154, Aug. 24, 1944, pp. 60–63.

7 "On Adhesives and Adhesive Action," by J. W. McBain and D. G. Hopkins, *Journal of Physical Chemistry*, vol. 29, 1925, pp. 188–204.

8 "Films of Adhesives," by J. W. McBain and D. G. Hopkins, *Journal of Physical Chemistry*, vol. 30, 1926, pp. 114–125.

9 "Adhesives and Adhesive Action," by J. W. McBain and D. G. Hopkins, Great Britain Dept. of Science and Industrial Research. Second Report of Adhesives Research Commission, 1926, pp. 34–89.

10 "Adhesives and Adhesion: True Chemical Compounds as Adhesives," by J. W. McBain and W. B. Lee, Proceedings of the Royal Society of London, series A, vol. 113, 1927, pp. 606–620.

11 "Adhesives and Adhesion: Mechanical Properties of Films of Adhesives," by J. W. McBain and W. B. Lee, *Industrial & Engineering Chemistry*, vol. 19, 1927, pp. 1005–1008.

12 "Adhesives and Adhesion: Relation of Joint Strength to Tensile Strength of Films," by J. W. McBain and W. B. Lee, *Journal of the Society of Chemical Industry*, vol. 46, 1927, pp. 321T–324T.

13 "Adhesives and Adhesion: Pure Chemical Substances as Adhesives," by J. W. McBain and W. B. Lee, *Journal of Physical Chemistry*, vol. 32, 1928, pp. 1178–1184.

14 "Adhesives and Adhesion: Gums, Resins, and Waxes Between Polished Metal Surfaces," by J. W. McBain and W. B. Lee, *Journal of Physical Chemistry*, vol. 31, 1927, pp. 1674–1680.

SEAT COMFORT

By FRANCIS E. RANDALL

CONSULTANT, OFFICE OF THE QUARTERMASTER GENERAL, WASHINGTON, D. C.

THEORY OF SEATING

AIRCRAFT are carefully designed mechanical instruments which incidentally attain flight. In all those aircraft in which a human pilot is used as the basic control equipment, it should be just as essential to make provisions in the design for the installation of that piece of equipment as it is for any other portion of the aircraft. The functional aircraft in flight includes the pilot. Besides the human mind, there are two other portions of the human mechanism which are basically important to the successful flight of the plane. These are his eyes and his four extremities. For the direct mechanical use of these two types of machines, it is obviously reasonable that they be placed in a position which is best suited for their use with the other parts of the aircraft. The Wright brothers succeeded in their original plane by the simple expedient of placing the pilot in a prone position, worrying little about the visual field of the man, since he never rose far enough from the ground to require a very large range of vision.

However, with modern aircraft, the field of vision must be assessed down to fractions of a degree before successful flight performances of the entire system can be anticipated. With this rigid restriction placed upon the pilot, it is again obvious that the primary factor regarding his positioning would be his eyes. If the position of the eyes is defined in the design of the plane, then it becomes necessary to suspend the man at eye level in such a position that he will most efficiently be able to conduct the mechanical functions of his behavior. This objective must be attained through proper positioning of the seat so that the pilot's body will be retained in the required position. But the problem is not that simple.

If only a positioning were required, we could resort to boards. But we involve ourselves in that unknown field which is called comfort. Let us pause to investigate what we mean by comfort. It is due, essentially, to a lack of conditions which will give rise to what we call discomfort, or a general feeling of pain resulting from many causes. Also, there is the factor which we call fatigue. Both these factors are interrelated, so let us look at the complexities which give rise to discomfort and fatigue. If we can succeed in eliminating all or part of these, we should then be well along toward achieving comfort.

CAUSES OF FATIGUE

Fatigue may be due to extended muscle activity, to vibration, to temperature, to humidity, to strong vapors, and numerous other things. Whatever the reasons are, the fatigue will result in accentuation of other factors which are giving rise to discomfort. These are mainly posture of the body and the method of support of the body. In either case, our basic problem is the alleviation of localized pressures inside or outside the body. Pressures inside the body arise from the forcing of joints into unnatural positions, which will introduce compressions of the joints and extensions of the ligaments and muscles normally involved in the joint motion. Pressures outside the body result from both the areas supporting the body and the unit pressures applied to different portions of the body. The factors involved in the production of fatigue are, to a great extent, soluble by usual mechanical means, but the factors involved in the production of comfort must be considered as mechanical corollaries of body mechanics and structures. We must make every effort to reduce pressures to the minimum before we can expect to accomplish much in achieving comfort for the individuals concerned.

As a specific example of our problem, let us consider the head and neck region of the body, a region which seldom receives support from a seat structure. How can we reduce fatigue of the neck muscles and increase comfort for the pilot or passenger by objective study of the seat? Simply this: Normally the head is balanced on the cervical (neck) vertebrae. Very little work is expected of the muscles attached to the trunk and the head in maintaining this balance. Suppose, however, that we mechanically remove the cervical vertebrae from their normal erect position, by increasing the seat-back angle away from the vertical, but yet we require the eyes to look directly forward. The muscles at the front of the neck will then have to pull the head forward and downward. It will quite often be slight, but if the effort is required for a long period of time, eventually fatigue will result, and the discomfort pain will appear. Or, let us take another example. We place a passenger in a comfortable seat, but we put windows in the side of the plane which are relatively quite high, requiring the person to "crane" his neck to look out of the plane. In a short while this condition will again produce fatigue in the neck muscles and will again have developed discomfort.

This principle will hold for all jointed portions of the body. Our efforts should always be directed toward maintaining continuously the normal balance between opposing groups of muscles.

ELIMINATING DISCOMFORT

Finally, assuming we have attained our objective of balancing the muscles of the body, how do we alleviate discomfort due to excessive external pressure? This is the simplest of all, but apparently is least often attained. In theory, we alleviate excessive discomfort due to external pressure merely by increasing the area of support for the body to the maximum possible. There will be a question which will immediately arise in this respect: Can we eliminate discomfort completely by the areas which are possible on the posterior surface of the human body? Not completely, is the answer. However, it has been established that nearly all discomfort can be eliminated for a period of 8 or more hours, which should be of economic value in commercial aircraft, since it is here that the question must be asked at all times as to whether passengers should be seated or bedded for travel. More seated than bedded passengers may be carried, so this should be the condition in so far as possible.

Let us return now to our pilot whom we have suspended at eye level. The seat, which originally seemed simple, is actually a complex mechanical system, because it is not merely a structure upon which the man sits, but it is also an integral part of the function of the aircraft since it is working to prevent dis-

The paper, of which this is a slightly abridged version, was contributed by the Aviation Division and presented at the Fall Meeting, Boston, Mass., Sept. 30–Oct. 3, 1946, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

NOTE: The researches discussed in this paper were conducted at the Aero Medical Laboratory, Engineering Division, Air Materiel Command, Wright Field, Dayton, Ohio.

comfort and fatigue in the pilot so that he may more efficiently perform his duties. Not only must it maintain the position of the eyes and the four extremities in the best mechanical manner, but it must also maintain the positions of nearly all the joints of the human body in such a manner that undue stresses and strains are prevented. Furthermore, it must provide actual support to certain exterior portions of the body in such a manner that excessive local pressures are prevented.

Examples of these two duties of the seat will serve to clarify our problem. Suppose the seat holds the average pilot in such a manner that the reference point, intersection of back and seat proper, is just 34 in. from the rudder pedals. We find that about 37 per cent of the pilots will suffer from cramping of the lower legs, because the feet are not properly balanced. Merely by increasing this distance to an average of 35½ in., we can alleviate this condition. Another example of the cause of discomfort is encountered in the back. Ordinarily the seat back is considered merely as a rest for the vertebral column of the pilot. But this is far from true, because it actually supports 15 per cent of the body weight if it is fulfilling its mission as a functional structure. With this much body weight to support, it must be given much more consideration than previously.

METHOD OF SEATING ANALYSIS

In a paper presented in 1940, by Messrs. W. E. Lay and L. C. Fisher, Department of Engineering Research, University of Michigan, a device termed the universal test seat was described. With this instrument these two men had developed a method by which they could objectively assess the physical properties of seating as a direct relationship to the morphology and mechanics of the human body. The methods used by them and the techniques of analysis of the data obtained represent the first great step forward in the study of seating as a problem in engineering. Their methods stand today as the best known. The studies conducted in the Army Air Forces on the seating of pilots were based upon their techniques, with modifications as required for the particular problem.

The universal test seat consists of an adjustable chair, mounted on a screw jack so that it may be adjusted vertically. Included in its construction are five adjustments: (1) An adjustment for varying seat depth, that is, the distance from the front edge of the seat to a point of intersection between the seat and the back; (2) one for varying the angle between the seat portion and the horizontal; (3) one for varying the angle between the back of the seat and the vertical; (4) one for varying the fore-and-aft position of the chair; and (5), an adjustment for varying the height of the back with relation to the seat portion. There are appropriate scales which indicate the amount and degree of each adjustment.

The seating surface consists of a light fabric, a thin cushioning pad, and a series of cylindrical coil springs of equal resistance, 1½ lb per in. of compression. In the seat portion there are 42 of these springs, each one of which is acted upon by 9 sq in. of seating area. In the back there are 49 springs, with ½ lb per in. compression, each similarly representing 9 sq in. of seating area. From the center point of attachment of each spring to the seating area there is attached a nylon cord which is let down through guides to a chart. This chart is calibrated in inches and serves to record the amount of compression of any individual spring. This is done by means of a white mark placed on each cord at a point calibrated as zero on the chart when no one is sitting on the seat. Also incorporated in the seat are adjustments for varying the amount of spring compression in any tier of 7 springs.

For the purposes of studying seating of the pilot, it was found to be advisable to establish some sort of relationship between this chair and an airplane cockpit. This was done by means of constructing a set of aircraft controls which were mounted in front of the test seat. A considerable adjustment was incorporated in the controls to the extent that there were 4 in. fore and aft in the rudder pedals and 13 in. fore and aft and 4 in. vertically in the control column. In addition, fore-and-aft adjustment was added through the seat adjustment.

Still another piece of equipment was used in conjunction with the apparatus described. This was a stationary preflight trainer designated as the Beindorf Trainer, Model B, which is a device for simulating flight on the ground visually. It consists, essentially, of a sphere on which is painted landscape, horizon, and sky. Movements of this sphere are controlled by the conventional controls of the aircraft.

Returned combat fighter and bombardment pilots were used as subjects. The fighter series, which preceded the bombardment series, was required to sit for eight consecutive hours, with adjustments made on the seat whenever required by the pilot. It was found that the first four hours were crucial, so the later series on bombardment pilots was conducted on four-hour tests. The seat adjustment which provided the longest period of comfort was arbitrarily taken as the final result.

It should be clearly understood that these tests concern themselves only with fatigue and discomfort resulting from mechanical processes, with air conditioning, noise, and all other variables held to the best conditions possible. Results obtained will, of course, be modified by the introduction of these other factors, but certainly they cannot all be studied at one time, hence we must pick one factor with which every pilot will be concerned, and that is the seat and control system.

Because no previous work had been done regarding the problem as to whether or not there is one fixed position in which the body is most comfortable, there was introduced a set of variable dimensions, upon which all other dimensions became dependent. This set of variables was based upon the vertical distance from the eye level to the level upon which the heels rested. In the fighter series this dimension ranged from 35 to 43 in., and in the bombardment series, from 37 to 45 in., since bombardment pilots are somewhat larger, and also since down-vision is more important in the bombardment type of aircraft.

Included in the testing of the pilots was a very intensive series of anthropometric measurements, which are considered necessary to establish reference bases for the population size control. All conclusions to be discussed include the corrections required by slight differences in the average body sizes of the different subseries.

In general, it would seem that the techniques first used by Lay and Fisher,[1] and later in the present researches, would be equally applicable to seating studies related to seating of passengers, desk workers, machine operators, and to any other type of seating requirements.

DISCUSSION OF COCKPITS

As a result of the researches conducted by the methods described, it was soon determined that certain basic principles always hold: (1) Cockpits must fit pilots; (2) there are only two bases upon which cockpits need to be defined in terms of aircraft construction and operation; the stick and the wheel-type controls. Otherwise, the human being actually should determine the basic dimensions of all cockpits.

Contrary to earlier suspicions, it was found that all the ranges in dimension from the eye level to the heel-rest position would provide seating conditions which were equally comfortable, provided certain laws were adhered to. At the present time, it is impossible to state these laws in any other than

[1] "Riding Comfort and Cushions," by W. E. Lay and L. C. Fisher, *S.A.E. Journal*, vol. 47 (Trans. section), 1940, pp. 482–496.

empirical ways, but these should serve to guide us in future researches. Much remains to be learned, but we are confident that we are on the right track.

With the range in dimension from eye level to the heel-rest position being 8 in. for fighter pilots and the same for bombardment pilots, but beginning 2 in. higher, and any level within this range being equally comfortable, then what are the laws to which we must conform?

The first, and most important, law is this: For any dimension picked, or let us call it any cockpit level, we must adhere to dependent dimensions just as rigidly as we would to dependent dimensions associated with other mechanical structures. Fig. 1 is a diagram which gives the general array of dimensions associated with arbitrary 2-in. increments within each of 6 in. ranges. Suppose we choose the 37-in. level, wanting to retain the pilot in a relatively flat position. By reading across the chart horizontally, noting each dimension, we arrive at certain dimensional relationships. But a 41-in. level will require several dimensions which are different from those of the 37-in. level, as would any other level within the range. The values in Fig. 1 are confined to the ranges between 37 and 43 in. for two reasons: (1) the 35-in. level is so flat that little room is left above the pilot's legs for inclusion of an instrument panel; (2) the 45-in. level is so high that the vertical adjustment for the very short pilot is difficult to attain without special rudder adjustment vertically.

So far as the vertical and longitudinal dimensions are concerned, there is little to be said beyond that which is included in Fig. 1. Reference to it should serve as a guide in cockpit designs.

ACTUAL SEATING REQUIREMENTS

Let us look more closely at the actual seating requirements. It should be noted that the included angle between the seat and the back remains at 101 deg. The main problem in the installation of the seat is the angle between the seat and the horizontal, which decreases with an increase in cockpit level and increases with a decrease in level. This is necessary to provide adequate thigh support.

Inherent in the requirements of the back of the seat is a very important set of provisions. There should be adequate sacral and lower lumbar support, because it is here that most of the weight of the trunk is carried. Also, the lumbar support is necessary to retain normal vertebral curvature resulting from seating the body. Finally, the top portion of the back cushion must permit the upper thoracic and cervical vertebrae to remain in their normal erect posture, so that there will be no fatigue of the neck muscles.

Always, the position of the seat must be calculated in terms of the men who will occupy it in the aircraft so that the eye level may be maintained.

In addition to the requirements just noted, another important factor must be considered. This is the matter of application of forces to the surfaces of the seat while the body is in position upon it. This represents the most difficult aspect of the engineering involved, because it has been found that constant pressures over the entire body surface in contact with the seat are not comfortable. We must do more research on this matter in order to find the final requirements in terms of unit pressures required.

We know, now, that the greatest pressures will fall over the ischial tuberosities, with a diminution of them in all directions from these maximum levels. Further engineering will be required to provide a type of cushion which will provide the proper differential weight supports without changing in thickness, unless we are prepared to add adjustability to the seat to provide for the different weights and statures in addition to those already established by constant cushioning. Certainly cushioning is the final answer, but it must be a very active functional structure, nor the passive one which has ordinarily been provided.

In regard to passenger seating, the same principles will hold, with modifications possible which will enhance the enjoyment of good seating. The provision of foot rests properly placed as accurately as we must place rudder pedals, plus the inclusion of a head rest on an adjustable seat may be of ultimate benefit, but we must place the rest just as carefully as we place the entire seat, because it is merely a seat for the head, which is in turn connected with the remainder to the human body, so must be treated with the body.

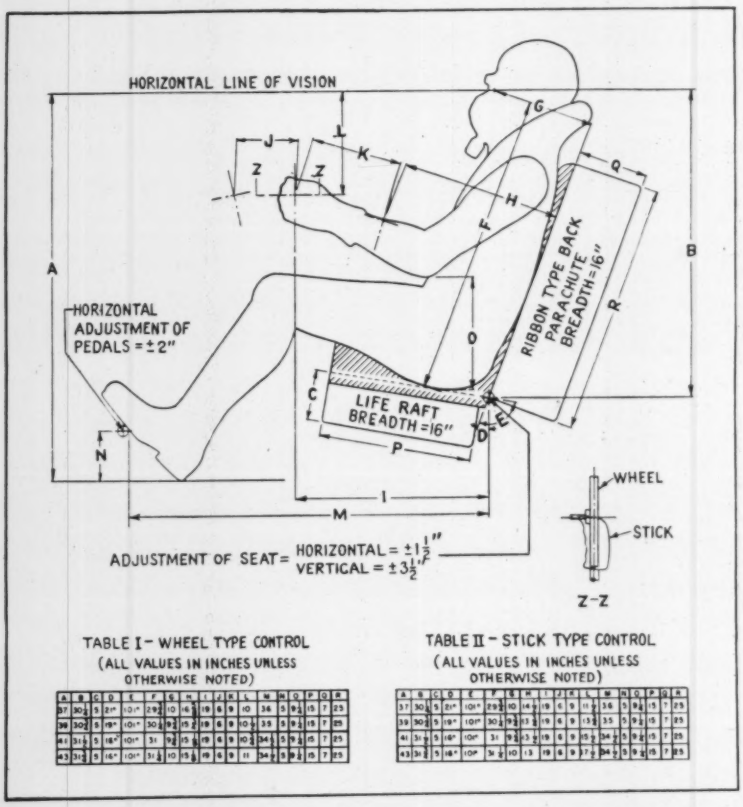


TABLE I – WHEEL TYPE CONTROL
(ALL VALUES IN INCHES UNLESS OTHERWISE NOTED)

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
37	30½	5	21°	101°	29½	10	14½	19	6	9	10	36	5	9½	15	7	25
39	30½	5	19°	101°	30½	9½	13½	19	6	9	10½	35	5	9½	15	7	25
41	31½	5	18°	101°	31	9½	13½	19	6	9	10½	34½	5	9½	15	7	25
43	31½	5	16°	101°	31½	10	13½	19	6	9	11	34½	5	9½	15	7	25

TABLE II – STICK TYPE CONTROL
(ALL VALUES IN INCHES UNLESS OTHERWISE NOTED)

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
37	30½	5	21°	101°	29½	10	14½	19	6	9	11½	36	5	9½	15	7	25
39	30½	5	19°	101°	30½	9½	13½	19	6	9	13½	35	5	9½	15	7	25
41	31½	5	18°	101°	31	9½	13½	19	6	9	15½	34½	5	9½	15	7	25
43	31½	5	16°	101°	31½	10	13	19	6	9	17½	34½	5	9½	15	7	25

FIG. 1 HUMAN DIMENSIONAL REQUIREMENTS IN AIRCRAFT COCKPITS

CONCLUSIONS

We may conclude from the discussion offered that the seating of the human body is actually a complex engineering problem, if done correctly. There is much to be learned about it as yet, with a great variation to be expected as the requirements vary with the jobs to be done by the person in the seat. In any case, the promises are great that the methods established by Messrs. Lay and Fisher[1] are available for further use in the study of all problems of seating. The economic value of the comfortable passenger or employee to any industry is manifold, and if for no other reason, every effort should be put forth to obtain the greatest degree of satisfaction in sitting that is possible.

ENGINEERS *and* INDUSTRIAL RELATIONS

By CHARLES A. MYERS

ASSOCIATE PROFESSOR OF INDUSTRIAL RELATIONS, MASSACHUSETTS INSTITUTE OF TECHNOLOGY

IN the past 15 years, American management, of which the professionally trained engineer represents a substantial proportion, has had to give increasing attention to industrial-relations problems. This was forced by a series of developments which have left many managements staggering under their impact. First came the depression, then government protection and encouragement of labor organization, followed by a tremendous growth in unions; then wartime labor shortages, postwar reconversion, and labor troubles; and now a period of continuing labor shortage in which more production can come only from greater utilization of the existing work force.

PRODUCTIVITY NOT A PROBLEM FOR LABOR ALONE

This increase in labor productivity is not solely, or even mainly, a problem for labor alone. Our tremendous increases in output per man-hour in the past have come through better management of the working force, utilizing the newest equipment, layouts, techniques, and procedures. The will of individual workers to work has undoubtedly grown in these periods but the increase in productivity has been generated and made possible by good management; and not by management's sitting back and waiting for labor to become more efficient.

Too often in the past, however, and even today, some managements and engineers have regarded industrial relations as something of a nuisance; as something apart from the real job of management. Management, in their view, was the organization of production through product design, layout of machinery and equipment, balancing of processes, routing of materials and orders, etc. Personnel and labor-relations problems, i.e., the field of industrial relations, were "headaches" which "interfered" with the real job of management. In desperation, these managements hired industrial-relations men or called in consultants; but too often, their roles were not clearly defined and the basic difficulties remained.

Actually, the most difficult problems of management are not primarily technical or engineering, but human. Engineers and other technical men have made more progress in their fields than those who have tried to specialize in human relations. But this is partly because management can hire a good engineer to solve a technical problem, but it has to do more than hire an industrial-relations man to solve its human problems.

As Lawrence A. Appley, a member of the General Committee of the A.S.M.E. and a distinguished industrial-relations man has so well said: "Management is the development of people, and not the direction of things."[1] Industrial relations and personnel administration, therefore, are not separate branches of management, but the very essence of management, permeating all levels and branches. Virtually every solution of an engineering problem, for example, is translated into effective action through other people.

INDUSTRIAL RELATIONS A TOP PRIORITY FOR ENGINEERS

It is clear therefore that industrial relations must be given more attention by engineers and top management than ever before. To repeat, this responsibility cannot be met simply by hiring an industrial-relations man or a consultant. Those who have wrestled with these problems in a consulting capacity know well how futile it is to attempt fundamental improvements in industrial relations without the full support and understanding of line management, from the top down. This is undoubtedly true of any kind of problem in industry; but it is so vital for industrial-relations problems because there is ordinarily less general recognition of their basic importance.

Managements need to be better organized to meet industrial-relations problems, both on the level of personnel relations and on the level of relations with unions. This requires a competent industrial-relations officer reporting to the chief executive of the enterprise. The industrial-relations man should have only staff responsibility; that is, he should advise, assist, and counsel all members of the line organization in their major problem of getting effective results through their subordinates. If he assumes direct responsibility for these problems, as some have, line-staff frictions develop which can wreck the whole spirit of teamwork in the organization.

In recent years, there has been an increase in the number of "consultants" and management-engineering firms which offer to help companies solve their industrial-relations problems. Inevitably, there are some quacks who offer a pet plan to bring the millenium in a company's industrial relations overnight. But by and large the majority of industrial- and management-engineering firms today are staffed by men who realize clearly that fundamental improvement comes slowly. They know also that, without wholehearted employee acceptance, little can be accomplished by such industrial-engineering or industrial-relations techniques as motion and time study, wage-incentive plans, job evaluation, and employee (or merit) rating

Engineers have made important contributions to the development of these techniques. It is only necessary to mention, for example, the work of two members of the Society's General Management Committee, Professor Barnes of the University of Iowa and Mr. H. B. Maynard, in motion and time study; of a member of the Executive Committee, J. K. Louden of the Armstrong Cork Company, in explaining the requirements of sound wage-incentive plans; and of another member of the Executive Committee, Prof. Asa S. Knowles, on merit rating. These men know, too, the limitations of these techniques and that none of them is a panacea for a firm's industrial-relations difficulties.

In fact, other less technical aspects of industrial relations are often more important. The pioneer studies made at the Haw-

[1] "Management the Simple Way," by L. A. Appley, *Personnel*, vol. 19, Jan., 1943, p. 598.

Contributed by the Management Division and presented at the Fall Meeting, Boston, Mass., Sept. 30–Oct. 3, 1946, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

thorne plant of the Western Electric Company by members of the Harvard Graduate School of Business Administration showed conclusively what every good administrator and manager had known intuitively, i.e., that attitudes and sentiments of workers make a tremendous difference in production.[2] Further studies by Prof. Kurt Lewin and his associates, now at the Group Dynamics Center at the Massachusetts Institute of Technology, have demonstrated that democratic methods of securing group co-operation in production and other human activities are clearly superior to authoritarian methods.

It is obvious that in dealing with human beings, whether in industry or in other forms of organization, the administrator needs more than a set of engineering techniques. He needs to develop the social skills which will win him the wholehearted co-operation of his subordinates. He needs to know that the best techniques will backfire and worsen industrial relations if they are installed without adequate consideration of the attitudes and sentiments of workers in the particular plant.

Properly conceived and administered, these techniques of motion and time study, job evaluation, and employee rating are certainly more satisfactory than offhand guesses and biased opinions which so often determine wage rates and differentials, and employee transfers and promotions. However, it is downright misleading to say that they measure output standards, job values, or employee performance as exactly as a yardstick measures the length of a room. This point needs to be stressed by every forthright industrial engineer in his relations with line management, lest management fall into the error of believing that these techniques rest upon scientifically accurate standards of measurement rather than upon informed judgment.

In a time study of a new job, for example, the actual reading of the stop watch for elapsed time is only a part of the process, though an important one. Human judgments are involved in the following steps: (*a*) Selecting the person to be timed, i. e., "the normal qualified operator;" (*b*) determining the conditions under which the time study is to be made; (*c*) deciding how many studies to make; (*d*) selecting the element times to get a cycle time for one complete operation; (*e*) rating the "effort" or "performance" of the operator being timed, sometimes called "leveling;" and (*f*) making allowances for fatigue, personal time, and unavoidable delays.

Considering these variables, it is no wonder that the average practice in time study differs so markedly from the best practice, and that workers and unions find a fertile source of complaint and criticism in many time-study results. These limitations of time study have been ably pointed out by William Gomberg, director of the management engineering department of the International Ladies' Garment Workers' Union (A.F. of L.)[3] Another penetrating analysis which should be read by every time-study engineer is the new book by Ralph Presgrave.[4]

JOB EVALUATION AND EMPLOYEE RATING

The judgment factor, as distinct from exact measurement, is even more evident in the newer techniques of job evaluation and employee rating. War Labor Board policies gave a tremendous boost to job evaluation during the war, and it is clearly a better method of determining the relative worth of different jobs in a plant than is guesswork. The number of wage inequalities on similar jobs in the average plant is amazing, and job evaluation has helped to reduce and eliminate these inequalities in most places where it has been introduced.

However, some managements and some practitioners have come to regard job evaluation as a "scientific" technique, which sets job rates so accurately that they are not open to question by workers or by union representatives. Actually, of course, job evaluation involves careful job descriptions and relative judgments of the worth of each job in terms of various factors which have been analyzed in the light of these descriptions. As in the case of effort rating in time study, judgments here can be misinformed, hastily arrived at, and even biased. An honest and forthright attempt by management to explain the procedure and minimize errors in judgment is better than any pretension that job evaluation is a scientific technique which cannot be questioned.

The same comment may be made on employee rating, sometimes called "merit rating." Here the raters are rating persons, not jobs, and possible errors in judgment due to bias and personal impressions are greater than in job evaluation. The principal case for employee rating rests in the fact that informal rating or judgments by supervisors are made constantly in the shop, and it is better to have a systematic method of developing informed judgments than to have them made on the spur of the moment when promotions, merit wage increases, or transfers require decisions. As in time study and job evaluation, the best practice is far ahead of the average practice and poorly conceived and administered plans may do more damage to good industrial relations than if there had been no plan at all.

Other fundamental limitations of job evaluation and employee rating have been discussed in the management literature and every management official using these techniques should be familiar with them.[5] But despite the limitations, improved methods of time study, wage incentives, job evaluation, and employee rating deserve wider use in industry. Employee acceptance in many cases can be secured by explaining the purposes of these techniques, by installing them very carefully and slowly, and by inviting the participation of workers or their union representatives in the actual development and administration of the techniques.

The argument over "management prerogatives" has often clouded the real issue. In unionized plants, it may be better to gain acceptance of these plans through joint participation than to retain management's sole right to formulate and administer them and be confronted with constant sniping and dissatisfaction through the grievance procedure. The real objective is greater production and the equitable sharing of the gains that result, rather than protection of prerogatives as such.

In conclusion, as these industrial-engineering techniques gain still wider adoption by management in the years ahead, engineers and industrial-relations men have a threefold obligation, namely, (1) to strive faithfully to improve their procedures, bearing in mind the limitations; (2) to impress upon management the wisdom of experimenting open-mindedly with ways of gaining employee acceptance of these procedures through joint participation; and (3) to remind themselves constantly that engineering techniques alone will not win the kink of employee co-operation essential to greater production.

---

[2] "Management and the Worker," by F. J. Roethlisberger and W. J. Dickson, Harvard University Press, Cambridge, Mass., 1940; also "Management and Morale," by F. J. Roethlisberger, Harvard University Press, Cambridge, Mass., 1944.

[3] "The Relation Between the Unions and the Engineers," by William Gomberg, MECHANICAL ENGINEERING, vol. 65, 1943, pp. 425–430.

[4] "The Dynamics of Time Study," by Ralph Presgrave, Industrial Organization and Management Series, McGraw-Hill Book Company, Inc., New York, N. Y., 1945.

[5] On job evaluation, see, for example, "Functions and Limitations of Job Evaluation," by Robert Tilove, *Personnel*, vol. 22, January, 1946, pp. 206–214; and "Wage Determination: Trick or Technique," by Solomon Barkin, *Labor and Nation*, vol. 1, no. 6, June-July, 1946, pp. 24–26.

On employee rating, see, "A Case History in Merit Rating," by R. S. Driver, *Personnel*, vol. 16, May, 1940, pp. 137–162; "Training as a Means of Improving Employee Performance Rating," by R. S. Driver, *Personnel*, vol. 18, May, 1942, pp. 364–370, and "Merit Rating Criticized," by Thomas Arthur Ryan, *Personnel Journal*, vol. 24, May, 1945, pp. 6–15.

COLLECTIVE BARGAINING *at the* CROSSROADS

By PHILIP TAFT

ASSOCIATE PROFESSOR OF ECONOMICS, BROWN UNIVERSITY, PROVIDENCE, R. I.

ABOUT 15,000,000 workers are today organized into labor unions. Their organizations constitute what we regard as the labor movement. The term "labor movement" covers a wide variety of organizations which differ in age, type of membership, the character of the leaders, bargaining position, discipline, fraternal benefits, and general policies. In fact the term labor movement is an abstraction used to cover a large number of widely different organizations.

While it is accurate to think of an over-all labor movement in the sense that all seek the same vague objectives, we should not overlook the wide diversity in their internal administrations and in their relations with the employer. Not only are there differences between international unions—and it may be said an international union is one in a trade or industry with locals in several parts of the United States and Canada—but considerable differences may be found in "sister" locals in the same international union. It is fair to ask: What are the causes of these differences? The answer is by no means simple. Differences in the attitude of locals may be due to the type of workers that make up the local, the history of labor relations in the industry, the character of the leadership, and the length of time the local has been organized. No precise weight can be given arbitrarily to each of these four factors, but that they are among the more important elements influencing the attitudes and policies of labor unions there can be no doubt.

UNIONS ARE JOB-CONSCIOUS

There are, however, some attitudes which are fairly common in all or most labor unions. Unions tend sooner or later to become primarily job-conscious. Their conduct is scarcely ever determined by broad considerations such as the effect of a policy upon the economy or upon labor in general. This does not imply that there is anything immoral or unusually narrow or selfish in the conduct of labor unions. Organized and engaged in bargaining for wage and other conditions in the factory, mine, or mill, the union regards conditions of work primarily from the point of view of the group it represents. This attitude accounts for the existence of jurisdictional disputes. No one can offer a satisfactory defense for industrial warfare that arises as a result of a struggle over union jurisdiction. Yet, while unjustified, it is yet necessary to understand the basis for such conduct. Most old types of jurisdictional disputes arise as a result of the struggle for jobs between groups of union men; for example, the lather feels that any work taken over by the carpenter means less employment for his group. He thus fights to prevent the encroachment of another group of trade unionists upon his job.

In virtually every other respect, the union approaches the economic problem from the same general point of view. What is the effect upon us, our members? Of course, we might argue that this point of view is narrow and unrealistic, that no group can prosper while others are in penury. This may be correct, but few of us act upon broader considerations in our daily economic life. Businessmen rightfully direct their major attention to the survival and prosperity of their own business, and only incidentally worry about the survival of the free-enterprise system. This is as it should be, for if they worried too much about the direction of social evolution, they might not find enough time to worry about such mundane problems as costs, competitors, and prices. Moreover, there is in the United States an ample stock of newspaper pundits, columnists, editorial writers, and college professors who can, while businessmen are worrying about staying out of the red, worry about the future of the economy.

Labor unions in this respect are similar to business enterprises, they are geared to serve the interests of their own members, and believe that in doing so the public interest will also be advanced. This is, in fact, an adaptation of the businessmen's philosophy that whatever is good for business is good for society.

To the author the recognition of this basic attitude is fundamental to a correct understanding of labor unionism. It needs to be said that, while the labor union is primarily concerned with the interests of its own members, it does not follow that its policies always operate to achieve this objective. Here again a comparison with the operation of a business enterprise may clarify the point in view. Rightfully a business firm is operated with the object of attaining the maximum of efficiency and the lowest possible unit cost. The specific policies may achieve the very opposite effect. Similarly, with labor unions, unenlightened policies, ignorance, prejudice, membership pressure may defeat the object of attaining the maximum total benefits the union is organized to achieve. Yet, this does not invalidate the notion that their primary interest is the achieving of maximum benefits for their members, and their policies, even if mistaken, are designed to achieve this objective.

LABOR UNIONS DO NOT INITIATE SOCIAL REFORMS

The fact that the labor unions are essentially concerned with limited job improvements has made them, in contrast to reform political organizations, relatively conservative. In no country have the labor unions ever taken the lead in movements for social reorganizations. Depending upon the individual point of view, this may be regarded as a compliment or criticism, but it is true that the trade unions have always been a check upon doctrinaires and theorists who urged rapid and major social transformation. Parenthetically, it may be said that this difference was recognized by Lenin early in his career. This was true in pre-Hitler Germany where the trade unions represented the extreme right wing of the German Social-Democratic Party; and it is true in England at present where the militant faction of the British Labor Party is made up of journalists, university teachers, lawyers, and professional men.

Of course, conservatism and radicalism are relative terms.

Contributed by the Management Division and presented at the Fall Meeting, Boston, Mass., Sept. 30–Oct. 3, 1946, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

Frequently you may be regarded as a conservative in some circles and a red-hot radical in others. An overwhelming proportion of American labor-union officials and an even greater proportion of their members would qualify as being conservative in the social sense. By that is meant that they are not adherents of a program for fundamental social reorganization; that they are content with slow and orderly progress such as has characterized the United States since its founding. While American labor unions have always been conservative in philosophy, they have always been vigorous in action and persistent in pursuing their practical objectives. In that respect, labor unions resemble other segments of American society. Americans are not addicted to windy metaphysical analysis but they are direct and aggressive in practice. As a result American unions have always been very keen for getting every possible concession a situation would yield. American labor instead of thinking in terms of the perfect society of the future has always concerned itself with maximum gains in the present.

THE BUSINESS APPROACH IN UNIONISM

The attitude of the American labor movement has been rightfully described as pragmatic business unionism. With the expansion of unionism into all of the strategic industries of our economy, the responsibility of labor has been greatly magnified, and upon the wisdom of its actions may depend its ability to gain the steady improvement of the lot of its members, an objective which the general opinion of the community endorses. Up to about 10 years ago, the policies and conduct of labor unions, while important, could not be decisive in determining the prosperity of our economy. Labor unions were, in the main, outside the principal industries. This is no longer true. Unionism and collective bargaining are today deeply established in every major industry. Thus labor unions need not only effective bargainers, competent negotiators, but leaders who understand the "economic facts of life."

Extension of labor unionism into the mass-production industries raises a number of problems. These industries are in continual search for new and better means of operation. Change and adaptation are embedded in their very character, and, if they are to continue to maintain their records of high output and low unit cost, they must not be hampered in introducing technical improvements.

On this point, the older and newer unions face different problems. In the older unionized industries, such as building construction, technical change while not absent has been relatively slow. Moreover, payment on an hourly basis is the general rule. Consequently, the problems of proper job evaluation and rate setting are not likely to arise. A different situation prevails in the mass-production industries. Change is continuous and technical changes frequently affect the content of the job. The introduction of a new gadget may relieve an employee of some part of his work, it may make the operation smoother and easier. Consequently, it is only proper to revise the rate which should enable the employee to earn as much as formerly, providing of course, he is utilizing the same skill and effort. Under these conditions the worker may lose sight of the improvements introduced by the company and the fact that he can earn as much as formerly throughout the day. He is instead likely to concentrate upon the unit rate.

The answer to this type of problem is in developing union officials who understand incentive wage-setting, and who are acquainted with job evaluation, and time and motion studies. Of course there will still be the need for the union officer to convince his members, a task that is not always easy to achieve, but the first step needs to be taken. Some unions have published manuals on time and motion study and on job evaluation, and some have engaged time and motion analysts to check upon company studies whenever there are complaints against an incentive rate. This at least is a recognition that progressive industries must utilize progressive methods.

OBSERVANCE OF COMMITMENTS BY UNIONS

Perhaps the most important need in a labor organization is the observance of the rules and commitments by the membership. A union that is unable to enforce discipline forfeits, to some extent, the right to be recognized as the authorized representative of its members. An employer's acceptance of a bargain with the union rests upon the assumption that the union will abide by the agreements and will not engage in any suspension of production during the term of the contract. Unless this condition is met, the union has defaulted on its terms, and the concessions granted by the employer have been vain and useless.

Discipline and the carrying out of agreements must be the corner stone upon which collective bargaining and the labor movement rest. This is both the most necessary and the most difficult task which labor faces. Especially is this true in the mass-production industries employing thousands of workers. A small recalcitrant group can force a suspension of the entire plant employing thousands. This is due to the interdependence of processes and operations. Whatever may be the cause, the results of lack of discipline are undesirable and costly. Under these conditions there can be no question of stable and peaceful relations, and no possibility of developing the goodwill and confidence essential to orderly collective bargaining.

The willingness of union members to abide by their commitments is influenced by the character of union organizations. In considering the type of unions we want, employers and other citizens should avoid a number of illusions assiduously propagated by popular writers. The main need is well-managed unions. In considering this issue, we should ask ourselves what makes a well-managed union? There is a tendency in some quarters to stress democracy, control of action by the rank and file. While these demands have always been part of the program of those dissatisfied with the conservatism of trade unions, these proposals are now endorsed by many others. Before a proposal is endorsed, we should ask ourselves the question whether it will aid in making the union more effective in its relation to industry.

PROTECTION OF WORKERS' RIGHTS WITHIN UNIONS

We should bear in mind that a union operates on two planes. It is important for society to prevent oppression of the individual worker. The union member must be protected against arbitrary action of his officers. This involves protection against false charges and the establishment of due process within the organization. Unions also set up procedures for trials and appeals of members charged with violating the rules of the union. In addition, members can, after they have exhausted the remedies allowed by their organization, appeal to the courts, although the courts have, in the past, been reluctant to interfere with the verdict of the union tribunal unless there is clear evidence of the violation of public interest, denial of a fair trial, or some other form of oppression. There is some, although by no means conclusive, evidence that there is need for reinforcing the protection of the individual against oppression.

This issue is complicated by the real need for enforcement of discipline by union leaders, for we must always bear in mind that a union also has relations with the outside world which it must maintain. Of course everyone favors democratic unions, but we must be careful that unions do not become so democratic that the union officer will neither give leadership nor direction. Nothing more disastrous could happen to industrial relations

than that eventuality, and in fact some of the recent labor difficulties are due precisely to too much democracy, by which is meant a too ready response to the undisciplined wishes of the membership.

FALLACY OF SMITH-CONNOLLY ACT

The Smith-Connolly Act is based upon the fallacy that the general membership is more disciplined than the leaders. For some reason the authors of the Smith-Connolly Act assumed that the leaders of unions promoted strikes; and if the rank and file were allowed to decide the issue of striking by secret ballot under government auspices, strikes would become rare. It is well known by all students and established by experience, as well as by common sense, that the union leaders are less anxious to call strikes than the rank and file. This attitude is not necessarily related to greater social responsibility or vision of labor leaders. It arises from their position and not because of their superior merit. The leaders of labor suffer from no grievances as they are employed by the union and, consequently, they are faced by no urgent need to correct a grievance. Strikes cost the union money and it means that funds must be paid out from the union treasury. Strikes may be lost; and they arouse public opinion against the union organization, to which labor leaders are far more sensitive than the rank and file. For all of these reasons the leadership will try to avert strikes whenever possible. Many times the leaders are forced to agree to walkouts despite their own judgment because of the pressure of the rank and file. Unless the position of the leaders is strong and stable they must respond to rank-and file pressure.

RELATION OF UNIONS TO WELFARE OF SOCIETY

The spread of unionism into the strategic industries and the increase in national bargaining raises a number of questions. Assuming that the workers in an industry vital to the well being and even the existence of the community have a merited grievance, are they justified in strangling economic and social life and inflicting untold injury upon the economy and society? Discussions of this issue are frequently obscured by the claim that men have a right to take action for a redress of grievances.

It seems to the author that the injury any action inflicts or is likely to inflict upon the community must be taken into consideration. Even the criminal law recognizes that punishment must fit the crime, and civilized men are revolted when they hear of inhuman or excessive punishment. In the matter of labor relations, the issue of several cents an hour or working rules do not seem of such great importance as to justify the infliction of great damage upon the community.

Great power should be exercised only when it is a question of survival. For if society is continually threatened, remedial measures will be found. Society cannot allow itself to be slowly or swiftly strangled by industrial warfare and the failure to use great power sparingly will inevitably bring controls.

Some labor leaders use their newly found power as the nouveau riche do their newly found wealth—waste it. In the early 1930's, the present apostle of free enterprise and the Elizabethan phrase, John L. Lewis, was begging for government intervention in the coal industry and asking for reasonable treatment by industry, and who can predict what the future will bring. A wise policy is one that is cognizant of public opinion, one that does not unnecessarily arouse public anger and opposition.

LABOR'S RESPONSIBILITIES IN ACHIEVING A HEALTHY ECONOMY

With the greatly increased importance of labor unionism in our economy, the unions must recognize that they share, with management and Government, a responsibility for a healthy economy. Policies must be designed that will enable us to continue to enjoy a high level of employment and national income. A severe decline in employment and income will not only affect union membership and union income, but one of the strategic groups in our economy, labor, will bear in the minds of the public some share of the blame for the hardships that will follow. Labor unions are regarded as having an important voice in the shaping of our economy and they are likely to suffer severely if it begins to slide downward to low levels.

Collective bargaining exercises an important influence on wages. It is likely to eliminate discrepancies in wages that are sometimes founded on fortuitous circumstances. In many instances a community's wage structure just "grows up," and collective bargaining may eliminate inequalities which are not based upon a sound economic foundation. In eliminating inequalities, we must recognize that differences in wages for similar work are frequently justified because of the different circumstances and position of firms in an area. Firms that need few skilled workers may be able to pay a higher rate because they do not constitute an important part of total wage costs. Some firms have more skillful managements than others; some are better situated competitively than others, and these accidental factors may have to be reflected in the wage structure, for otherwise the less efficient firm may not be able to operate. The choice may be between a top rate and unemployment, and a wise leadership will take into account these possibilities in making its decisions. Leadership will also recognize that management is entitled to a fair return and that boosting wages to too high a level can be harmful to both industry and labor.

CONCLUSION

The next few years are likely to be difficult and will require patience and perseverance. We have just fought the greatest war in history, and it is not possible to uproot millions, to encourage shifts in employment and in standards of living without at the same time creating difficulties of adjustment. Mental and emotional reconversion to peace is as difficult as conversion to war. In many respects reconversion to peace is by far the more difficult for the feeling of urgency and national peril is no longer present. In addition, the tensions and dissatisfactions that were repressed or held in reasonable check during the war are at last released. Therefore, we find that our economic difficulties are complicated by emotional ones. The satisfaction of helping the country, working for civilization is gone. More than ever the job is only translated into monetary rewards.

In a period such as this we must be extremely careful not to allow ourselves to be governed by anger even if justified. Let us remember that the modern world is highly unstable and the community cannot afford to divide itself into mutually hostile camps. In this respect we might learn from England. As many readers know, in 1926, England faced a crippling general strike of alarming proportions. One of the leaders of the strike was Ernest Bevin, the present Foreign Minister. Mr. Churchill who was at that time a member of the government favored vigorous action against the strikers. His advice was unheeded. England, while laboring under great provocation, did not fundamentally weaken the trade unions. The result was evident in the war, when English labor loyally supported the government, and allowed dilution of skills and suspension of many hard-won standards. The English worker remained a loyal member of the British community and not its enemy hoping for its destruction.

Let us also think with our heads, and whatever remedial steps are taken should be carefully thought out and based upon sound reason and experience. Let us do nothing that will create class antagonism in American society and let us remember that our present troubles are the aftermath of the great struggle just completed.

A REPORT *to the* COUNCIL *of* E.C.P.D.

By EVERETT S. LEE

CHAIRMAN, ENGINEERS' COUNCIL FOR PROFESSIONAL DEVELOPMENT

WE meet again at the close of another successful year for the Engineers' Council for Professional Development. I say successful, for in spite of the difficult and changing conditions of the year we have maintained our organization, we have advanced our influence, and we have broadened our vision appropriate to the unbounded strength and contributions of the engineering profession.

We are fourteen years old. Our fourteenth birthday was October 3, 1946. We have lived through a business depression and a World War. We have heard the engineer denounced because of his contributions; technocracy was his sin. We have heard the engineer revered; his contributions helped to save the nation. And we have seen the world stand in awe at the revelation of nuclear power, contribution of the scientist and the engineer. Yet the engineer, as citizen and member of society, feels that he is just another man, recognized on occasions, yet just another man.

E.C.P.D. was born of the Conference on Certification. Its general objective is "the enhancement of the professional status of the engineer." Its immediate objective is "the development of a system whereby the progress of the young engineer toward professional standing can be recognized by the public, by the profession, and by the man himself, through the development of technical and other qualifications which will enable him to meet minimum professional standards."

The program of E.C.P.D. is progressed by its four standing committees: Committee on Student Selection and Guidance, Committee on Engineering Schools, Committee on Professional Training, and Committee on Professional Recognition.

STUDENT SELECTION AND GUIDANCE

The Committee on Student Selection and Guidance "shall report to E.C.P.D. means for the educational and vocational opportunities of engineers in order that only those may seek entrance to the profession who have the high quality, aptitude, and capacity which are required of its members." To this end the committee this year reports for student selection the continued excellent and outstanding results of the Measurement and Guidance Project in Engineering Education, sponsored jointly by the Carnegie Foundation for the Advancement of Teaching, the American Society for Engineering Education, and the E.C.P.D. The pre-engineering inventory battery of entrance examinations has been increased until 12,307 students were examined in the last year to give a total of 20,218 students tested in the 36 co-operating colleges of engineering in the last three years. And all colleges of engineering having curricula accredited by E.C.P.D. which are not participating in the program have now been invited by the committee to participate.

Extension of this project includes the development of experimental forms of sophomore achievement examinations, the discussion of the preparation of senior examinations, and the proposal to develop high-school guidance tests. These projects will thus give a complete series of examinations and tests from the high school through the engineering college, to establish valid bases by means of which both individuals and engineering institutions may establish the efficacy of their work, the rate at which progress is being made, and the reliability of their educational policies. Tremendous importance attaches itself to the realization of these significant objectives. Truly we owe a debt to those in E.C.P.D. who brought this opportunity to the attention of the Carnegie Foundation for the Advancement of Teaching and to the Foundation for the outstanding thoroughness and completeness with which the project has been progressed and is being extended.

For student guidance the committee has continued the distribution of "Engineering as a Career." The total distribution to date of "Engineering as a Career" has been approximately 73,000 copies since February, 1942. For the year 1945-1946 it has been 23,393 copies sold and 500 without cost. Those sold were distributed as follows: Colleges 19,710; High schools, 210; Professional organizations, 2,269; Commercial agencies, 229; and Book stores, 975; a total of 23,393.

The number of copies distributed to high schools is much too small. To the end of establishing circulation in the high schools the committee is planning to accomplish this purpose through the local sections of the member societies of E.C.P.D. Letters have already been sent to more than 200 chairmen of such sections of the engineering societies. Here is an opportunity for extension of both individual and group engineering contribution to explain the fundamentals of engineering training to high-school students. E.C.P.D. has continually fostered this work, and again we call upon all engineers to give their time to aid and perform. The Committee on Student Selection and Guidance will continue this work. I urge that all possible support be given to it. Professional engineers must assume a very solemn obligation in the guidance of embryo engineers in order that the engineering life of these young men may be made more abundant. The improvements effected by engineers must, moreover, be instituted to a greater extent by engineers in order that such benefits may be derived without uprooting the lives of great segments of the world's population. The engineer of the future must not only create, he must learn to apply the fruit of his labor so that human happiness may be enhanced and human misery may be reduced. There is much for us to do in this regard.

ENGINEERING SCHOOLS

The Committee on Engineering Schools "shall report to E.C.P.D. means for bringing about co-operation between the engineering profession and the engineering schools. As an immediate step, the committee shall report to the Council criteria for colleges of engineering which will insure to their graduates a sound educational foundation for the practice of engineering." To this end the committee this year reports that it has held its inspections of curricula to a minimum during the last four years as the committee believes that engineering colleges cannot be fairly judged while operating under war conditions. A few inspections were necessary to complete studies already begun or to prevent injustices to certain institutions.

It is the opinion of the committee now that all curricula hitherto accredited should be re-examined as soon as possible after conditions return to normal, and that early inspection should be made of nonaccredited curricula where a delay might cause injustice. To this end a brief questionnaire was sent to all institutions to gather preliminary information on signifi-

Presented at the Fifteenth Annual Meeting, New York, N. Y., Oct. 18-19, 1946, of Engineers' Council for Professional Development.

cant changes in faculty, curricula, laboratories and equipment, admission requirements, and graduation requirements, and to determine factually when the schools considered that they would be ready for examination. From the answers that have been received it would appear that most institutions would prefer to postpone inspections until 1947–1948, whereas a few indicated that they would be back to normal in 1946–1947. The answers to the questionnaires received indicate that, in general, institutions are holding closely to regular admission standards.

The committee feels that the inauguration of a program of accrediting graduate curricula should receive early attention. However, it is reasonable that such a program should be postponed until regional committees have completed a major portion of the necessary review of undergraduate curricula.

The status of the accrediting program by curricula and by institutions is shown in Tables 1 and 2. These tables indicate the outstanding scope of this work done with such great credit by the E.C.P.D., and also gives an idea of the great magnitude of the task ahead in the next years of the re-examinations.

TABLE 1 STATUS OF THE ACCREDITING PROGRAM (COLLEGE) BY CURRICULA AS OF OCT. 19, 1946

	Number	Per cent
Fully accredited	502	74.0
Provisionally accredited	78	11.5
Not accredited	95	14.0
Action pending or deferred	3	0.5

TABLE 2 STATUS OF THE ACCREDITING PROGRAM (COLLEGE) BY INSTITUTIONS AS OF OCT. 19, 1946

Approximate number of engineering-degree-granting institutions in U. S.	167
Institutions inspected (not including reinspections)	143
Institutions having one or more curricula accredited	133
Institutions inspected but having no curricula accredited	8
Institutions reinspected but having no curricula accredited	2
Institutions applying but inspection deferred	5
Institutions that have not applied	19

Last year we were glad to report the establishment of regional committees for the accrediting of technical-institute curricula, and this year we were glad to report the inauguration of the program together with the recommendations for the accrediting of seven curricula at three institutions. Thus, in these few words, we record the results of much work for good, and I am sure we express our greatest appreciation to Dean Hammond and his subcommittee for the vigorous progression of this important work.

We are also glad soon to have results from the subcommittee under the direction of Dr. Cullimore with regard to the practical application of the pre-engineering inventory which has been functioning under the Committee on Student Selection and Guidance as reported under the work of that committee. Now a subcommittee under the Committee on Engineering Schools is to study those factors which should be considered in connection with the pre-engineering inventory and its accompanying achievement tests as they relate to problems affecting standards of instruction and educational procedures in engineering schools and to explore the possibilities of inventorying the personality factors which might serve as complementary to the work undertaken and proposed in connection with the pre-engineering inventory and its achievement tests.

The subcommittee has prepared memoranda concerning the two phases of student development which it was created to consider. The first proposes some points by means of which the individual rating of the pre-engineering inventory within separate institutions may indicate the competency of the students admitted. The second covers the work that has been done in setting up an inventory of personal characteristics to supplement the pre-engineering inventory. Thus is the work carried on so well by the Committee on Student Selection and Guidance being carried over into the Committee on Engineering Schools for practical application in that field.

PROFESSIONAL TRAINING

The Committee on Professional Training "shall report to E.C.P.D. plans for the further personal and professional development of young engineering graduates, and also of those without formal scholastic training." To this end the committee calls to our attention that for the past six years the training and development of young engineers has been seriously impaired by well-known conditions. The studies of these young men frequently have been condensed into too short a period for them to give proper reflection on the professional aspects of their lives and even their studies may not have been as effective as they normally would have been. These abnormal conditions impose a challenge to all constituent bodies of E.C.P.D. and their members to do their utmost to give to these young men the heritage to which each is entitled. The young men whose professional education has been interrupted and those who are about to enter engineering colleges have a right to expect from the profession especially thoughtful and sympathetic help so they will not be seriously handicapped by the deficiencies which these abnormal times have imposed.

The committee has listed twelve aids and procedures to assist in the development of professional engineers from college graduates. Some have been put into effect and some need revision; others need to be put into effect by general personal co-operation This appears to be an individual professional duty and a rewarding privilege in enlisting the imagination, enthusiasm, and knowledge of youth with the outlook and experience of age for professional betterment. Since the work of this committee deals largely with points of view and psychology and can only be put into effective use to such extent as the profession and engineers wish, it behooves all to help to determine useful principles and practices and consistently to assist in putting them into effect. The E.C.P.D. "Manual for Junior Engineers" will give great opportunity to strengthen this program. In this regard we expect the manuscript soon and we visualize that it will provide the means of cystallizing the interest which we know resides in the hearts and lives of engineers for this work. With it in hand we can proceed more effectively. This we must surely do. In the paraphrased words of the late Prof. Charles F. Scott: "Are we living up to our own obligations as engineers if we neglect or refuse to share in the training of those who are to succeed us in the organized work of our profession?"

PROFESSIONAL RECOGNITION

The Committee on Professional Recognition "shall report to E.C.P.D. methods whereby those engineers who have met suitable standards may receive corresponding professional recognition." To this end the committee report this year emphasizes the many varied and special interests in the profession with a plea that there be in the future less specialization, that we get together on a code of ethics, and that member grades in the technical engineering societies be made uniform.

Also there is the continual emphasis on the need for the engineers working to advance the recognition of the profession through public acceptance, through civic and political endeavor through publication, screen, and churches.

New and reactionary groups are enthusiastic, aggressive, and organized to win. Unless those who wish to retain our present mode of life grow equally inspired, aggressive, and organized, our children will surely live under a different economy, and free enterprise will be a thing of the past. Shall we become partici-

pants in preventing this or complacently relax back and bemoan? The answer lies not with the engineering profession at large, but with the individual reader of this paragraph and with each engineer for unpostponed political participation.

"Eternal vigilance" is the price of liberty, and its parallel in unity is: Eternal watchfulness and conscious effort is the price of unity. The tendency toward fragmentation has been pointed out. This is a real hindrance to professional unity. Technical and scientific interest in specialization is allowed to take the place of a broader interest in the common activities of the profession. The committee addressed a letter to each of the local engineering societies throughout our land suggesting that they hold at least one meeting each year to discuss their relations to E.C.P.D. Response to this letter has been good. Our effort among the local sections will be directed to the things that are common to all branches of engineering and are helpful to all fields of specialization. This is a further followup of our "Will You Help?" pamphlet. The answer is with the local engineering societies themselves.

ENGINEERING ETHICS

Our special committee on Principles of Engineering Ethics under Dr. D. C. Jackson's patient leadership reports progress; there are now three draft proposals together with various suggestions and the committee will meet to consider these. Anyone familiar with the long history of this work will recognize the difficulties of joint action. We are glad to report that E.C.P.D. has continued with patience to progress this endeavor and we trust successful conclusion will be attained in the not-too-far-distant future.

EMPLOYMENT CONDITIONS

Our special Committee on Employment Conditions for Engineers was set up to collect information regarding the broad question of unionism for engineers and submit a report of its findings. To this end the committee has regularly reported for information the situation existing in this regard in the United States and Canada. With the passing of time has come a clarification of the status of the engineers and unions, together with a recognition and understanding of this, to the end that the committee has asked to be discharged, with the understanding that an observer from E.C.P.D. will sit with the Committee on the Economic Status of the Engineer of the Engineers' Joint Council. This arrangement has in effect been made this year and it has been to advantage.

The report of the committee is detailed as to employment conditions and a summary statement to include all of the details cannot well be made, except, I think it can be said that the understanding of the situation is such as to safeguard the engineer if he will work for his position as conditions may require. The continued activity of the Engineers' Joint Council in this regard will be of most useful value.

COMMITTEE ON INFORMATION

The Committee on Information continues to give of its ability to the needs of E.C.P.D. and, in addition, this year reports the work for the Engineers' Joint Council on the listing of the engineering societies in the United States and Canada as to the "grade of membership subject to such admission requirements that membership may be considered as a recognition of professional standing in the engineering fraternity." The report made to Engineers' Joint Council listed 251 engineering societies in the United States and 12 in Canada. It is our hope to continue this important work now that it has been initiated to the end that there will be available at all times an up-to-date list of the engineering societies of our country together with the information as to professional status which will afford classification opportunity. To this end we are setting up a special committee on the listing of engineering societies. I am happy that E.C.P.D. has been able to start this work.

REPRESENTATION ON FEDERAL COMMITTEE

Last year we were asked by Dr. Studebaker, Commissioner, U. S. Office of Education, to name a representative to the Citizens' Federal Committee on Education. The committee has had one meeting to see the picture of Federal participation in education; a second meeting is expected soon. E.C.P.D. is glad to be a participant in this important work and we feel honored at being included in the professional group.

SERVICE TO VETERANS

We were glad during the year to render service to the veterans who inquired of us about college curricula. We have had over 500 mail inquiries from veterans individually, or through groups, and these were answered either by sending a list of schools or a copy of "Engineering as a Career" or by advice co-ordinated through the secretaries of the societies. For the early part of the year our telephone inquiries or office calls from veterans averaged four or five each day. These personal calls are fewer now, but undoubtedly we helped approximately 1000 young men during the year.

We are glad of this contribution and we are glad also that there is recognition in it of the part which E.C.P.D. is taking in the services for the young men. And, may I add, that this work was practically entirely handled and co-ordinated by Miss Elsie Murray, secretary to the chairman. I speak of it not only for this particular service, but as being indicative of much larger services to be rendered.

FIFTEENTH ANNIVERSARY BOOKLET

We in the engineering profession are proud of our profession and we have given much time, work, effort, and thought to progressing our ideals and objectives. Much has been accomplished; much has yet to be done. We in E.C.P.D. have discussed this variously in the last few years, and with the coming of the fifteenth successful year of our history, we visualized an undertaking to give us the means for more extended accomplishment. To this end the Executive Committee voted to appoint a small planning committee of three to lay out a program for increasing E.C.P.D.'s income and provide a permanent professional-development fund through whatever agency would be considered desirable. Your planning committee has worked hard, and at this Annual Meeting it has presented the material for a booklet commemorating the achievements of the engineering profession and outlining the needs and program for future years to be appropriate to these achievements and to those to come. We have made of it a fifteenth birthday celebration. We trust you will like it. With success we should be able to enlarge our program to render for the engineering profession a recognition which it deserves, and to engineers the recognition they deserve. This is a program for engineers by engineers. It will have to be undergirded by a constant application of time and contribution from every member of all of our engineering societies in accordance with the "Will You Help?" program which we inaugurated two years ago which we have been advancing, but which needs additional outlay, services, and facilities to make it perform and attain consistent with the hopes and the wishes of engineers throughout our profession. In this program we have thought in large terms as the engineering contributions of the past have made us so think. We must proceed in large terms. This we propose to you. This we propose to do.

And, in closing, as in other years, we speak again our appreciation of all the contributions which have so gloriously been made to the work. May they increase.

BRIEFING THE RECORD

Abstracts and Comments Based on Current Periodicals and Events

MATERIAL for these pages is assembled from numerous sources and aims to cover a broad range of subject matter. While few quotation marks are used, passages that are directly quoted are obvious from the context and credit to original sources is given.

Civil Service

A BOARD of U. S. Civil Service Examiners for the Scientific and Technical Personnel of the Potomac River Naval Command was officially organized on Oct. 1, 1946, according to an article by Dr. R. C. Duncan in the October, 1946, issue of the *Report*, published by the Naval Ordnance Laboratory, White Oak, Md. The formation of this board marks the culmination of a recommendation made in a joint letter from the Naval Research Laboratory, the Naval Ordnance Laboratory, and the David Taylor Model Basin, in June, 1945, that the authority for the evaluation of new employees be delegated to the laboratories.

The board will be made up of a group of scientists whose work will be devoted exclusively to the procurement and evaluation of scientific and technical personnel. It differs from the usual Naval Board of Examiners, or Labor Boards, in which the chairman is the Regional Civil Service Director, and the senior member, or acting head, is a naval officer, and which is concerned with all types of employees, only a small percentage of which are in the professional or subprofessional services. By approving this type of board, the Navy has indicated its high regard for the contributions which the Navy expects from its scientific personnel, and has recognized the scientific service as a definite and integral unit in the Naval organization. Thus the organization of the board is of great importance to the scientists and engineers of the country in general, and to the scientific service of the Navy in particular. So far as is known, the board is also unique in another respect in that it is the first Board of Examiners in the country which is composed of scientists and devoted exclusively to the scientific service.

The importance of the board to the war-service and temporary scientific employees of the activities in the Potomac River Naval Command lies in the fact that the first effort of the board will be devoted to the establishment of the mechanism, in accordance with Civil Service regulations, by which such employees can be given the opportunity to qualify for probational Civil Service appointments, which lead to permanent Civil Service status.

While the board cannot immediately begin to function effectively, in that its offices must be acquired and furnished and its administrative and clerical staff obtained, the board is already starting a survey of all the positions in the Potomac River Naval Command for which examinations should be announced. These examinations will probably all be of the "unassembled" type, that is, each applicant will be rated on his training and experience, which he will present to the board in his application (C.S. form 57). These forms will be rated in accordance with standards established by the board with approval of the Civil Service Commission. Registers of those passing the examinations will be established and eligibles from these registers certified to the personnel officers of the respective activities for appointment.

The over-all objective of the board will be to serve the activities represented in every way possible within its authority. As authorized by the Executive Order, the Civil Service Commission is not relinquishing any of its responsibilities. The board merely acts as an extension of the Civil Service Commission. The over-all arrangement appears to be an ideal one. The board members, all scientists by training, are members of the staffs of individual Naval establishments. They are familiar with the needs of the Navy in general and with those of their own organizations in particular. They are concerned with obtaining the very best type of scientific personnel for the Navy's services and will be responsive to the special problems of the activities served, and yet as board members they are each commissioned as a Civil Service Examiner by the Civil Service Commission and carry the authority of the Commission.

Electronic Sorting Machine

AN electronic sorting machine, developed by the Electric Sorting-Machine Company, Grand Rapids, Mich., rapidly separates objects according to their color. The machine is described in *Product Engineering*, October, 1946, and is used principally to examine foodstuffs such as peas, beans, lemons, peanuts, corn, seeds, and coffee beans. Generally installed in batteries, each electronic sorter has a capacity of about 100 lb of pea beans per hr or 62 beans per sec. Operation is continuous and automatic except for emptying the receptacles into which the discards are thrown. Two types of the machine have been designed, the "dark trip" and the "bichromatic." The dark-trip type is sensitive to dark or light objects and can be adjusted to discard certain percentages of the objects inspected if they are in various stages of discoloration. The bichromatic machine is sensitive to all shades of a color or can be set to select one color or a number of colors from either end of the spectrum. White and various shades of yellow corn kernels can thus be sorted.

Acceptance or rejection of the object, say, a bean, is based on the percentages of red and green light reflected by it. The machine feeds the beans one at a time before an optical system consisting of a light source, a focusing lens, two mirrors, two filters, and two phototubes. Light from the incandescent lamp falls on the bean and some of it is reflected through the focusing lens to the first mirror. This mirror reflects part of the light through a red color filter and onto a phototube sensitive to red light. The remainder of the light hits the other mirror to be reflected through a green filter and onto a phototube sensitive to green. Output of each phototube is fed through dual-channel amplifiers and from there to opposite-deflection electrodes of a cathode-ray tube. One phototube controls the vertical sweep of the cathode-ray beam and the other the horizontal sweep. Degree to which the beam is deflected in either direction depends on the amount of the red or green light reaching the phototubes. A mask covers the "acceptable" area on the face of the cathode-ray tube. Unacceptable beans deflect the electron beam off the mask so that the beam shines onto a senti-

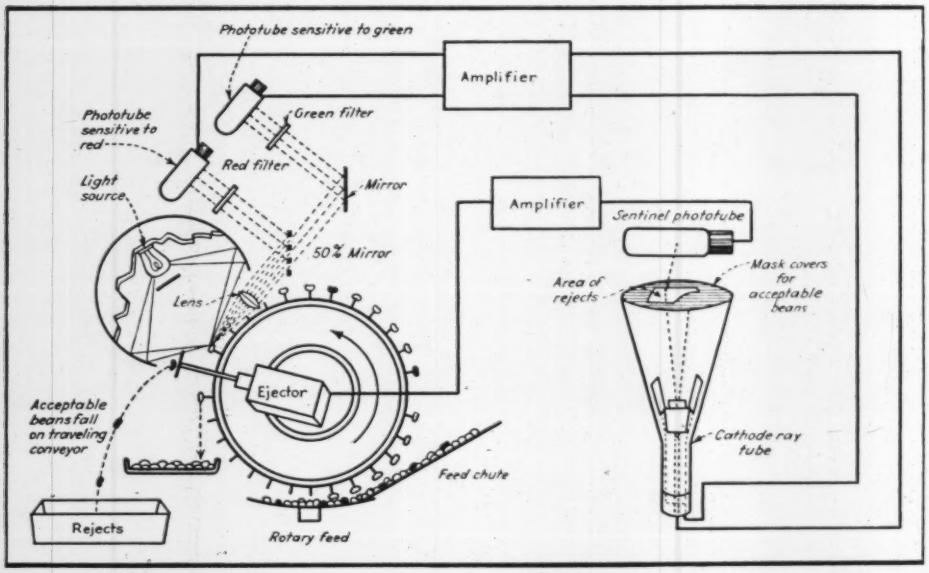


FIG. 1 SCHEMATIC DIAGRAM OF ELECTRONIC SORTER

nel phototube that operates an ejector mechanism to discard the faulty bean.

A feed chute leads beans to a vacuum wheel having numerous tubes fixed on its periphery. A centrifugal blower causes a vacuum of $1^3/_4$ lb to act through the tubes drawing a single bean onto each ferrule as it rotates at 107 rpm through the feed chute. As the wheel turns it brings the bean before the light source. If not acceptable, the solenoid ejector, operating at sixty-three $^5/_8$-in. strokes per sec, will push the bean into a "discard" receptacle. If acceptable, the vacuum is broken and the "good" bean drops onto a conveyer belt. Before the particular ferrule can pick up another bean, 150 psi air pressure is blown through the tube to clean the orifice of any skin particles that might prevent reloading.

Plastic Tooling

IN recent months, Thomas A. Dickinson, consultant for several West Coast plastics concerns, has visited more than 100 plants in which plastic tooling is being used for production purposes. His report appears in the October, 1946, issue of *The Tool Engineer* and reveals that plastics have found a permanent place in tool fabrication.

Phenolformaldehyde casting resins were the most often encountered plastic materials, probably due to their easy workability, their low shrinkage properties, and their strength.

Typical of the phenolics now in use is a material called Plastitool, produced by Duorite Plastic Industries, Culver City, Calif. It is said to have the greatest impact resistance of any phenolic now on the market, and it can be used to produce finished casts in less than 20 min.

The tools being produced range from small lathe and checking fixtures to large drill jigs and stretch dies.

Plastitool is mixed with a catalyst in a bakery cake mixer. If high-speed curing is important, a "hot catalyst" may be used. The regular catalyst requires six to eight hours of curing but produces casts with the highest strength properties. The mixed material is poured into a plaster or similar mold, whose surfaces have been coated with lacquer and wax. Curing is accomplished in an oven at 150 to 200 F. The cured article is removed from the mold as soon as it has had time to cool.

Mold shrinkage thus encountered averages 0.0025 in. per in. Although the finished casts weigh only 76 lb per cu ft, they will withstand compressive loads of more than 16,000 psi and can be machined like wood.

Diallyl phthalate thermosetting plastics derived from petroleum products by Shell Development Company, Emeryville, Calif., may eventually become close competitors to the phenolformaldehyde casting resins. These are liquid esters which may be distinguished by their ability to polymerize into hard clear solids—a transition which is so completely controllable that it may be accomplished in minutes or delayed indefinitely. They are not yet as easy to handle as the phenolics, but they should be desirable for many types of tooling because of their strength properties and transparency.

In the manufacture of drill jigs for contoured surfaces, plastic laminates are particularly desirable. These materials are ordinarily more expensive than previously described casting compounds, but they can be fabricated with such ease and in such complex shapes that their basic costs become relatively unimportant.

Typical of the high-strength laminates now available is Conolon, a material produced by impregnating Fiberglas with Metlbond resins and curing.

In general, the lamination of Conolon is such that all of the fabric fibers will be at an angle to one another. The curing may be accomplished either in a vacuum bag or in a hydraulic press at a pressure of 10 to 15 psi, and a temperature of 300 F (+ 25 F or —10 F) in a period of approximately 30 min depending on the thickness desired.

In the fabrication of various forming tools, thermoplastic casting resins have achieved a position of unparalleled importance. Although they do not have great heat resistance or impact strength, these materials are extremely easy to handle and can be salvaged innumerable times by melting.

Typical thermoplastics are ethyl cellulose and cellulose acetate butyrate. They are prepared for casting by melting in a double boiler whose outer container is filled with an oil bath to prevent overheating, and the casting is accomplished simply by pouring over or into a suitable form. For example, extremely cheap and useful drop-hammer punches can be made by pouring a molten ethyl cellulose material over a Kirksite die which has been suitably positioned in a wooden frame. Virtually all thermoplastic casting compounds have good compressive strength.

Plastic adhesives, such as Chrysler's Cycleweld, have made it possible to combine the advantages of plastics and metals in the manufacture of various tools.

Extruded plastic sections have been used to some extent in building up small assembly jigs or fixtures, but as a rule such tools were satisfactory only when there was no possibility of rough treatment.

In designing a plastic tool the most important considerations

should be given to the physical limitations of the material that must be utilized.

In casting complex shapes with thermosetting materials, the foremost problem is to eliminate air bubbles prior to curing the resin so as to avoid the production of a weak and porous cast. Therefore considerable attention has been recently concentrated on an old metals-fabrication process known as centrifugal casting.

Experiments at Rezolin Company, Beverly Hills, Calif., have shown that a modified version of centrifugal casting can be used to eradicate the air bubbles that are created when a casting resin is poured into a mold. It consists simply of spinning the mold for one to three minutes before placing the mold in an oven for curing.

This spinning may be accomplished by making a special setup with an ordinary drill press, or with any of several similar setups. Its purpose is to create centrifugal forces to dissipate air bubbles.

The plastics used in centrifugal casting may be mixed and handled in any ordinary manner, except for the spinning.

Concentricity Checking

AN instrument that greatly facilitates concentricity checking, both internal and external, on parts or products having varying diameters, has been designed and is being manufactured by Swanson Tool and Machine Products, Inc., Erie, Pa.

Checking and inspecting relative concentricities on round parts or sections have previously necessitated the use of conventional V-blocks in conjunction with gage blocks, planer gages, and other aligning tools such as surface plates, height gages, and indicators. In addition, the operation has formerly involved complicated and lengthy mathematical computation by the shopworker.

The new instrument, called a V-liner, is reported to eliminate all the foregoing complications and tools in this operation. It accurately and automatically determines the proper center-line heights required for any combination of diameters involved in a workpiece. This is accomplished by turning a properly compensated screw which raises the vertically adjustable V-block on the instrument.

The V-liner consists of two V-blocks mounted on solid members which are held in correct alignment by cylindrical rods. These hardened and ground aligning rods are pressed into the first V-block member and permit the second V-block member with elevating V-block to move as desired.

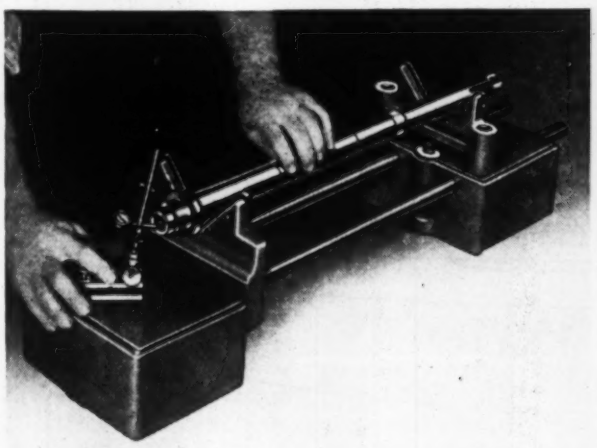


FIG. 2 CONCENTRICITY-CHECKING INSTRUMENT

Both V-blocks have replaceable hardened and ground tool-steel wear edges. The hardened adjusting screw and bronze nut, which raises or lowers the movable V on guide pins, is accurately calibrated and compensated for the sine of the V.

By setting the adjusting screw in accordance with the graduations indicated thereon to correspond to the diametrical difference between any diameter involved in any piece to be checked, the instrument is ready to position the part in a perfect horizontal plane for checking. As an example, if one section of a shaft is 3 in. in diameter and the other section $2^1/_2$ in. in diameter, it is only necessary to turn the adjusting screw under the movable V to the $^1/_2$-in. setting.

It is claimed that the instrument speeds up concentricity checking on all kinds of round work and reduces inspection and checking time on this type of work as much as 80 to 90 per cent. Its use insures a quick and positive check of the concentricity of internal and external diameters and quickly determines the concentricity of shafts of varying bores, counterbores, and outside diameters. It provides a means for finish-inspection of precision cylindrical parts and it may also be used for positioning and holding cylindrical parts on light milling, drilling, and surface-grinding operations.

Canned Drinking Water

TO the layman, water appears to be the simplest of products to can in a metal container. An article in the September, 1946, issue of *Food Industries*, by W. J. Mutschler, manager, packaging laboratory, Continental Can Company, Chicago, Ill., relates some of the container and processing problems involved which made the canning of drinking water very difficult.

Water is a constituent of all naturally occurring food products, many of which are canned with ease. However, water promotes rapid rusting of any iron with which it is in contact, can be a medium for carrying pathogenic bacteria, and has the singular characteristic of expanding when freezing. Pure water contains no flavoring elements to hide off-flavors that can be absorbed during its preparation for packaging or during its storage in a container. All of these characteristics make it an extremely difficult material to can satisfactorily in a metal container. As early as 1930 work was carried on in the research laboratories of the Continental Can Company to develop a suitable metal can for mineral waters or other waters that possess desirable medicinal qualities. It was found that water could be packed in standard packers' cans using high filling temperatures and low head-spaces, but once such cans were opened, the water had to be consumed or rusting would develop very soon. Furthermore, even these cans developed metal hazes in the water, which affected its acceptability. It was not until the beer can was developed that it was possible satisfactorily to pack water in a reclosable container.

At the time canned beer was first marketed commercially in January, 1935, work had already been started on experimentally packing many beverages other than beer in this type of can. It was shown experimentally that many types of mineral and carbonated waters could be satisfactorily canned in beer cans without any rusting since the beer-can linings were specifically developed to prevent any metal exposure. Consequently, when an investigation was started in 1941 at the Northwestern University Medical School by Dr. A. C. Ivy, under the auspices of the National Research Council, to develop a satisfactory container for emergency drinking water for fliers forced down at sea, the problem did not appear to be insurmountable. In fact, by March, 1942, sufficient experimental work had been com-

pleted by Dr. Ivy, in co-operation with two major can-company research laboratories, to indicate that either the cap-sealed or flat-top beer can was a satisfactory container for water. More important, a method had been developed for packing the water in cans in such a way that it would be potable after long periods of storage at tropical or arctic temperatures and at very high altitudes. Also, canned water could be subjected to unusually rough treatment and remain intact and potable.

A summary of the tests conducted at the Northwestern University Medical School is also included in the article.

Samurai Swords

THE Japanese have always been a martial nation and therefore valued their weapons greatly. Of these the sword was considered the noblest of all, and the blade is considered the noblest and most precious part of the sword. The samurai or sword-wearing class cannot be dissociated from his sword. The privilege and etiquette of wearing it, the deeds wrought with it, the superstitions and lore of centuries connected with it, the relation between its aesthetics and its practicality—these are some of the reasons why his sword ranks above all his possessions in a samurai's esteem.

Until the year 1876, when the open wearing of swords in Japan except by military officers and court officials was forbidden by imperial decree, the wearing of two swords was the highest privilege of the samurai. One of these swords, the long or fighting sword (katana) was for enemies; the other, shorter wakizashi was for the wearer's own body in case of defeat or when one wished to sacrifice one's life for a noble cause.

An article in the September-October, 1946, issue of *Army Ordnance*, by Stephen V. Grancsay, curator of arms and armor, Metropolitan Museum of Art, New York, N. Y., reveals that unusual techniques were used by Japanese metalworkers in making these weapons.

The Japanese blade has an extremely hard and keen edge while the body of the blade is relatively soft. Blades were made of steel of sterling quality and every one was forged upon the anvil—beaten out of billets with skill and judgment by an artist.

Many different methods were employed in building up the billet from which the blade was finally forged. In one of the methods, plates of iron and steel were welded together. The resulting single plate was notched across the middle, folded on itself, welded together, and drawn out under the hammer to its original size. This process was repeated from twelve to eighteen times resulting in a billet containing many thousands

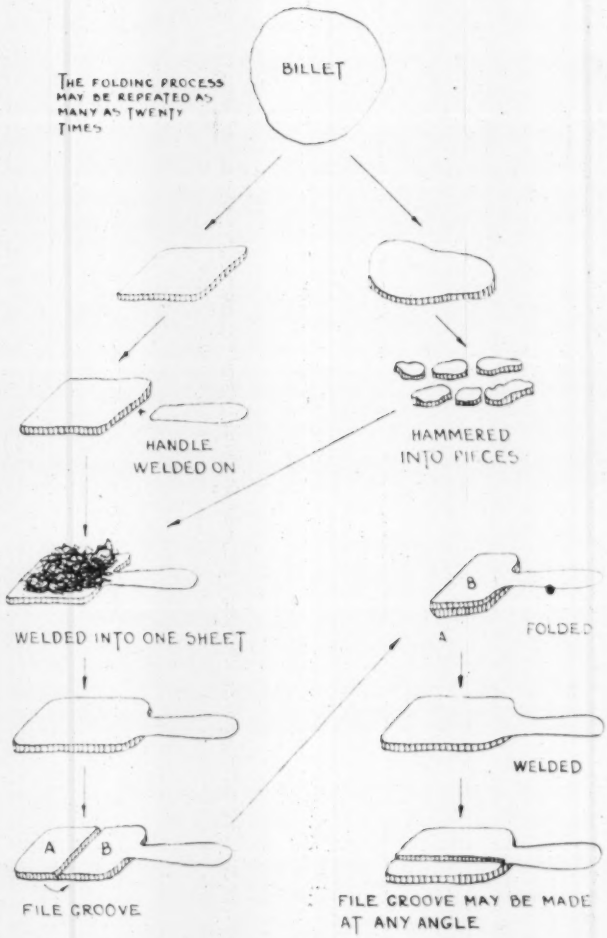


FIG. 4 PROCESS OF WELDING THE FOLDED SHEET

of layers of alternate iron and steel. In some cases several billets were prepared, welded together, folded, and hammered to the desired size.

Another type of constituent piece is made of a sheet of steel to which fragments or needles of similar but harder steel are welded, a process which resulted in producing the isotropic structure of the steel, Fig. 4. (The harder steel is made by throwing a sheet of steel into water while hot, then hammering it to pieces.) As many as 15 lumps of steel averaging $1\frac{1}{2}$

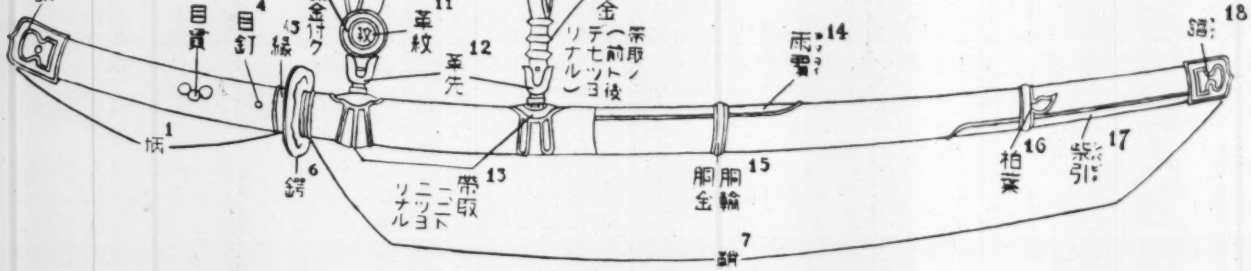


FIG. 3 DRAWING SHOWING MOUNTINGS OF A SLUNG SWORD (TACHI)
(These include the hilt and its apical and base caps, rivet, and ornament which originally concealed the rivet; the sword guard; the scabbard and its ferrules; chape and fittings.)

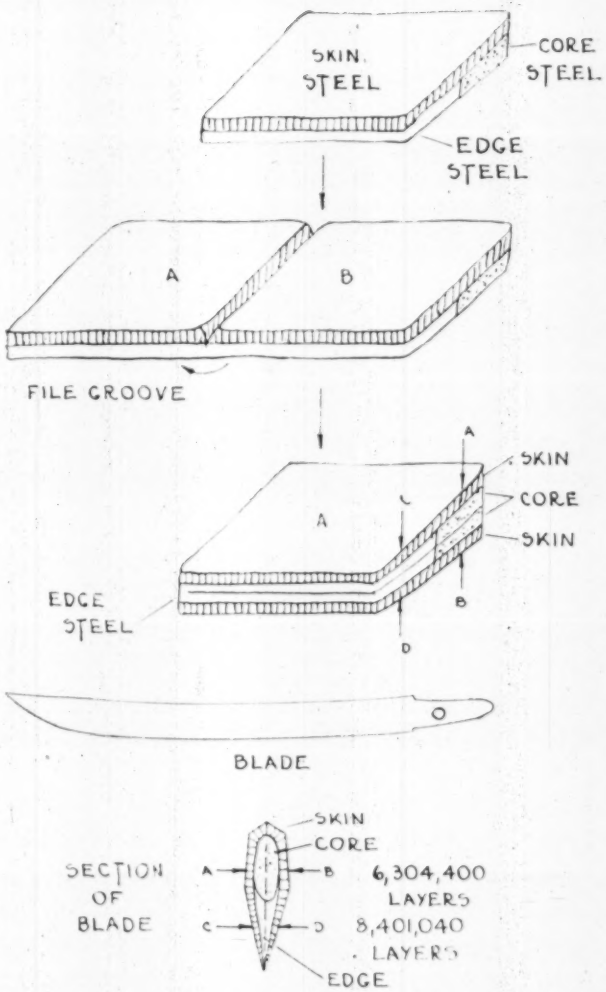


FIG. 5 DISPOSITION OF THREE TYPES OF STEEL WHICH ARE FORGED INTO BLADE

lb apiece may be required to make a blade weighing $1\frac{1}{2}$ to 2 lb when finished. It is the retention of good and elimination of bad steel which is the reason that so much steel is necessary for making a good blade.

Each of the small bits of steel is inspected before being used. If its edge of fracture is dense, granular, and homogeneous in structure and of a dull gray color, the steel is regarded as good. If the edge of fracture is cracked, glistening, and of uneven color, the bit of steel is rejected.

Another kind of compound blade was built of steel only, but of three varieties carefully selected so that each should possess the physical properties required in that part of the blade for which it was to be used. Thus the bar from which the blade had to be forged was built up and welded in such a way that one kind of steel formed the inner body or core; another, the sides (skin or cover steel); and a third, the edge.

The aim was to give the blade a combined structure of properly distributed hard and soft steel. For example, the edge steel (hagane) is theoretically folded 20 times and consists of 1,048,576 layers (2^{20}); the core steel is made by folding eight times, giving 256 layers (2^8).

The making of the skin steel (kawagane) is more complicated. Three square sheets, one folded 16 times, the second folded 6 times, and the third folded 7 times ($2^{16} = 65{,}536$: $2^6 = 64$; $2^7 = 128$), are hammered into a single rectangular sheet of 65,728 layers; the next step is to cut the plate in three and place one over the other, i.e., $65{,}728 \times 3 = 197{,}184$ layers. These are finally bent 4 times, i.e., $197{,}184 \times 2^4 = 3{,}151{,}944$ layers.

These three types of steel are finally welded together. Square pieces of core and edge steel are placed side by side, and a sheet of skin steel of the size of the core and edge steel together is placed over them. This is hammered into a rectangular piece, cut in two, and turned over so that the skin steel comes on the surface. This is hammered down into a blade—more than eight million layers having been welded and stretched out at the edge, Fig. 5.

The edge and point are the critical areas. After the blade is forged, it is given a special heat-treatment increasing the carbon and silicon content at the edge, which thereby becomes much harder than the rest of the blade. The extent of this hardening, and of the color change which accompanies it, can be exactly controlled. The tempering is usually accomplished during the eighth or the second month, for at these times of the year the water is considered most suitable for hardening the edge.

The pattern produced in the steel by the laminas of which it is built, and by the change of color at the edge, is called yakiba, at the point, boshi. These are readily distinguished by their lighter whitish color from the darker bluish color of the rest of the blade. The outline of the yakiba formed one of the distinguishing characteristics of different smiths and schools of blade makers. There are 32 recognized principal classes of outline, with several subdivisions. A narrow, straight, hardened edge or a simple irregular one is in general preferred, for a broad yakiba implies that a large breadth of the blade is brittle.

From the yakiba one may judge the quality of a blade and, indirectly, the authenticity of a signature on the tang, or determine its age and maker if not signed and dated.

The sharpness of a blade depends upon the technique of tempering. However, in addition to the quality of the tempering,

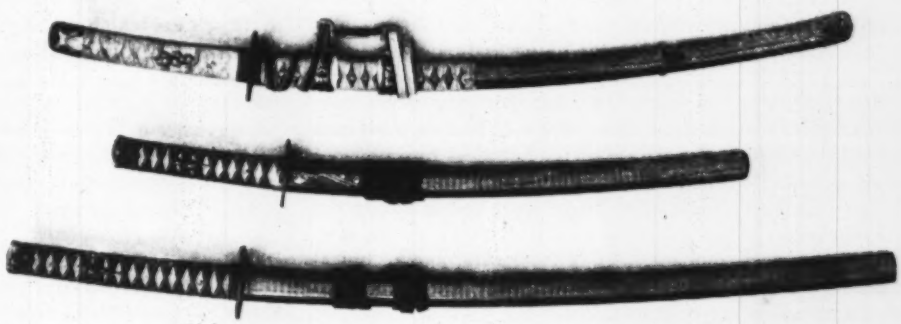


FIG. 6 SLUNG SWORD (*top*) ORIGINALLY USED IN WAR AND LATER USED FOR CEREMONY. SHORT (*center*) AND LONG (*bottom*) SWORDS INDICATED THE MILITARY CASTE

the position of the center of gravity of a blade is an important factor in determining its cutting power.

The tang (nakago) ends in one of three forms—square, round, pointed—or in an intermediate form. It is left rough, usually showing the marks of the smith's file, called the yasurime, in a characteristic pattern. The inscriptions on tangs usually include the bladesmith's name, the province where made, and the date. The tang provides an important clue for the authenticity of blades; from it may be determined the quality of the blade, while its file marks assist in distinguishing artists and schools.

After the tempering, the finishing steps are taken. The blade is carefully cleaned and roughly ground. The smith then judges whether the blade is satisfactory, especially whether the hardening is right and whether there are imperfections in the meral. Sometimes to lighten the blade, grooves or blood drains exactly semicircular in section are cut. Then the hole in the tang is drilled for the peg that holds it to the hilt.

The only decoration found on blades is that made by the chisel, which is used to produce grooves, inscriptions, sacred letters (bonji) as a charm, or pictorial carvings representing dragons, gods, flower sprigs, etc. The blade is finally ground, polished, and mounted. It is estimated that it required sixty days, working from early dawn to late at night, to finish a blade.

The care of the blade is of the utmost importance. When the sword is in use, the blade should be dusted with a rice-powder dabber (uchiko) twice a month in summer and once a month in winter, being finally wiped with a mulberry-fiber handkerchief or soft paper (hoshogami). Chamois might also be used. In the rainy season the blade should in so far as possible not be drawn. It should be kept in good condition and free from rust by a thin application of pure oil of cloves (choji-abura), or camellia-seed oil (tsubaki-abura), the superfluous oil being wiped away. If the weapon is put away, a position free as possible from damp should be chosen, and it should be well wrapped.

Feed-Pump Symposium

THE design, maintenance, application, installation, and operation of boiler feed pumps and feedwater treatment were discussed at a symposium held by the Anthracite-Lehigh Valley Section of The American Society of Mechanical Engineers, in Stroudsburg, Pa., recently.

R. J. Allen, chief metallurgist, Worthington Pump and Machinery Corporation, Harrison, N. J., presented a paper on the selection of materials for boiler feed pumps. Two factors determine the choice of materials to be used in their construction; these are the ability to perform effectively over a reasonable period of time and the over-all cost.

The selection of materials for any boiler feed pump, as is the case in most mechanical devices, is influenced by the prevailing trend in industry. The pump manufacturer evolves his own designs but he depends to a considerable extent upon others for much of the performance data which determines his choice of materials. He may or may not make all or a part of his own castings, but the basic types of alloys used in them are, in the main, the result of the accumulative research and development work of the steel companies, alloy producers, and technical societies. Co-operative industry tests augmented by his own research provides the variation detail.

Cast iron corrodes by a process known as graphitization.

The copper-base materials are normally resistant to the corrosive attack of boiler feedwaters, although under extreme conditions some of the zinc and aluminum bronzes may fail by processes known as dezincification and dealuminization, respectively.

The so-called stainless or, more properly, corrosion-resisting steels are quite immune to the attack of the boiler feedwaters because of a thin, almost transparent oxide film which develops at their surfaces. Chromium, as an alloying element, is most effective in imparting this property to steel.

Cast iron is a versatile material. It is relatively inexpensive; it can be readily cast into intricate shapes without undue porosity or hot tears; it is easily machined; it has good wear-resisting characteristics and, at low water velocities, is substantially resistant to corrosion. The one factor which reacts most against the use of cast iron in low-pressure casings is the difficulty of welding in the event of corrosion.

The cast iron used in pump casings is usually of the normal gray-iron type. Occasionally it is alloyed with moderate percentages of nickel and chromium, or molybdenum, or both, to develop greater soundness and somewhat higher physical properties.

Carbon steel, because of its better-balanced physicals, toughness, and weldability, was until recently the material most generally used in central-station boiler-feed-pump construction. Unfortunately, its sensitiveness to the corrosive attack of many boiler feedwaters and its pronounced tendency to pit and gouge have rather ruled it out for the high-pressure applications. Cast steel is regularly alloyed both to improve its physical properties and its resistance to corrosion.

Bronzes are not extensively used in the central-station boiler-feed-pump trim because their high coefficient of expansion makes it somewhat difficult to maintain clearances and to keep parts, such as impellers, tight on the shaft.

Aluminum and manganese bronzes, although endowed with excellent physical characteristics, are not used extensively in pump parts because of the foundry difficulties encountered in trying to eliminate the effects of dross and high solidification shrinkage.

Monel metal is resistant to the attack of boiler feedwaters but it is difficult to cast in large, irregularly shaped pieces. It has a hot-short solidification range which, in the presence of minute traces of lead and other impurities, favors the formation of hair-line cracks during cooling which are difficult to remove by welding.

Carbon steel could be more effectively used if some corrosion-resisting coating could be made to adhere, continuously and permanently, to the water surfaces. Attempts have been made to use plastics and sprayed-metal coatings of bronze, monel, and stainless, but none have been overly satisfactory largely because of the difficulty in obtaining adherence and freedom from pin-hole porosity.

Welded stainless steel is effective when applied as a coating to those areas which may cut or which have cut in service. The cost of application is extremely high and attack may occur at the transition zone if the facing is not carried well down into the volutes.

Experience indicates that the use of corrosion-resisting steel of the 5 per cent chromium or higher-alloy types is essential if long life is to be assured in boiler feed pumps intended for use in high-pressure stations.

MAINTENANCE

In a paper devoted to the maintenance of boiler feed pumps, Hugh Platt, eastern district engineer, Byron Jackson Company, pointed out that the important factors controlling the periods between overhaul are: (1) The extent of corrosion—erosion-resistant materials in the rotating parts and the case; (2) local feedwater and its treatment; (3) pressure per stage and pressure differentials within the pump.

Bearing temperatures, oil levels, and glands should be checked several times per hour.

Oil should be changed, the system flushed, and the bearings opened and inspected once a year or oftener if local conditions require.

Lubricated flexible couplings should be opened, thoroughly cleaned, the alignment checked, and relubricated at least annually.

The head and capacity should be checked at the normal speed with variable-speed units, at least every two months, preferably monthly, and the results tabulated.

With hard-surfaced shaft sleeves, lead or Babbitt foil packing with one or two rings of plastic may be used to good advantage. It is desirable to limit leakage to a very small trickle or even drip. Excessive leakage tends to wash out the packing and destroy it, as well as waste condensate. Metallic packing should never be used on bronze sleeves as it tends to gall or wipe.

Serious damage to new pumps can result from mill scale, welding slag or scale, and hard rust accumulating during construction, when the plant is started. It is advisable to install temporary strainers ahead of each pump, but these are not adequate to handle large quantities of trash and cannot be fine enough to keep out the comparatively fine particles which do the most damage. Nothing can replace adequate flushing. In flushing, a velocity of at least twice the full capacity of the system should be attained.

One problem introduced by the use of stainless steels is the tendency to gall when surfaces rub, particularly with lack of lubrication. This applies to stainless wearing rings when pumps lose suction and also when dismantling stainless impellers and sleeves with close fits on stainless shafts.

If impellers are shrunk on, force should never be used in removing them. They must be expanded with heat, as directed by the manufacturer, and tapped with a lead or soft hammer over the vein, but never forced.

In order to facilitate maintenance, it is a wise economy to have a spare rotating element.

There is one very important aspect of maintenance which is being neglected in a great many plants, and that is cleanliness. Many flaws, loose joints, and bolts can be detected before serious trouble results.

APPLICATION, INSTALLATION, AND OPERATION

Also at this meeting, Hans Gartmann, member A.S.M.E., assistant chief engineer, Central Pump and Compressor Division, De Laval Steam Turbine Company, Trenton, N. J., presented a paper on the application, installation, and operation of boiler feed pumps.

The great majority of the boiler feed pumps are so arranged in the boiler-plant cycle that the water flows to the pump suction from a direct-contact heater. A gate valve is usually mounted in the suction line and a check valve and a gate valve in the discharge.

A large proportion of the operating troubles in the past can be traced to lack of attention to the suction conditions of the pump. In order for the pump to operate properly there must be sufficient head on the suction to prevent flashing under all conditions of operation. Flashing at the inlet to the first-stage impeller will cause cavitation, reduction in capacity and, in extreme cases, loss of water which may lead to seizure of the pump rotor.

The selection of a boiler feed pump depends on the capacity, pounds per hour or gallons per minute, discharge pressure, complete suction conditions including net positive suction head and temperature (with maximum variation), chemical analysis, pH value of feedwater, and type and speed of driver.

The majority of boiler feed pumps are motor-driven. It is good practice to provide a turbine-driven spare pump for each boiler which can be put on the line in case of power failure.

With few exceptions, 3500 rpm is the standard speed for boiler feed pumps in the medium sizes. For larger sizes, say, above 1000 gpm, there is, however, still a definite place for a 1750-rpm pump. To mention just one advantage, they can be operated with a variable-speed slip-ring motor with a resultant saving in power at reduced loads where the total pressure to be developed by the pump is considerably reduced.

For smaller units, the tendency is to go to still higher operating speeds.

The piping to and from the pump should be so installed as to impose a minimum of pipe strain on the pump proper. Attention should be given to good alignment between pump and driver.

Before starting, care should be taken to vent the pump properly.

The lubricating system should be given proper attention. Use only clean pure oil of the proper characteristics as recommended by the manufacturers.

Protection against overheating of the pump must be provided by installing a by-pass from the discharge of the pump back to the heater.

For the average feed pump, provision should be made to by-pass about 10 per cent of the rated capacity.

FEEDWATER TREATMENT

At the same meeting feedwater and its treatment were discussed in a paper by J. B. Godshall, metallurgist, Cameron Division, Ingersoll-Rand Company.

Nearly all boiler feedwaters can be divided into two classes from the standpoint of the effect of the water on pump materials. The first group, class 1, includes feedwaters that consist chiefly of raw or treated make-up with only a relatively low percentage of condensate. By comparison, class 2 feedwaters consist almost entirely of condensate, and the very small amount of make-up required is usually evaporated.

Industrial power-plant feedwaters will almost invariably fall in class 1. Such waters are relatively stable from the standpoint of pH fluctuation because of the buffering action of the dissolved solids in the make-up. The temperature and pressures are usually lower than in central-station practice and it is not unusual to find that the water has not been deaerated to best advantage.

The class 1 waters can be divided into two groups, and suitable material selections can be made on this basis.

The first group includes most of the units handling principally raw water, provided batch injection of chemicals ahead of the pump is not practiced. The pH value of the feedwater is usually between 6.5 and 8.5.

The second group of class 1 includes units handling principally treated waters with a relatively high pH value, and ordinarily without batch injections of chemicals ahead of the pump. The pH value of the feedwater is usually between 8.5 and 11.0 and the water is substantially noncorrosive.

A third group could be added to class 1 to cover any feedwaters containing a high proportion of make-up that is not evaporated and containing chemicals affecting the pH value, particularly when the chemicals are added by batch injection ahead of the feed pump.

When the pH value fluctuates severely, it is usually more practical to modify the water treatment than to use materials capable of withstanding the severe corrosion. In one case the normal pH value was 9.3 but, in order to prevent excessive concentration of alkalinity in the boiler, sodium bisulphate was injected at the feed-pump suction once every eight hours. This treatment made the water acid for about thirty minutes every

eight hours and the pH dropped to an extremely hazardous 1.9. At this low pH value, the feedwater dissolved iron and steel rapidly, with hydrogen evolution, even at room temperature. Feed pumps failed by corrosion in about one week, but a simple modification of the water treatment raised the minimum pH to 9.0 and corrosion was substantially eliminated.

Central-station feedwaters will almost invariably fall in class 2 because no effort is spared to protect the boilers and turbines regardless of the possible effect on the boiler feed pumps. Make-up is seldom more than 2 per cent and is usually distilled water.

This yields an unbuffered feedwater which is extremely sensitive from the standpoint of pH fluctuation. A little carbon dioxide coming over with the steam may lower the pH value of the feedwater to 5.6 or very slight contamination with ammonia may raise the pH as high as 9.0. Condenser leakage, when acid circulating waters are used, has an effect similar to that of carbon dioxide.

In some cases, low pH values are avoided by continuous injection of a small amount of alkali or by recirculation of boiler water to a convenient point on the suction side of the feed pump. This practice is effective in minimizing corrosion but is not too attractive to the station operators because it introduces one or more of the following disadvantages: (1) A small but constant loss of heat; (2) an unnecessary increase in the total solids in the boiler water; (3) scale deposits on turbine blades, particularly on low-pressure turbines operating from desuperheaters.

Raising the pH value is a practical way to protect the pumps in service but cannot be considered in the selection of materials for new pumps because no station operator would be willing to guarantee to maintain present water conditions for the life of the pump. When new improvements can be made for protection of the boilers and turbines, the possible effect on the feed pump is a minor consideration.

It is unlikely that water treatment on a scale necessary to protect carbon-steel casings will be very acceptable to the operators. In fact the present trend is in the opposite direction. Several companies use no chemicals whatsoever, not even in the boilers. This results in an extremely pure feedwater which is good for the boiler but bad for the feed pumps.

Tire Pressure-Control Gear

A MEANS of varying the air pressure in the tires of a vehicle while it is in motion has been developed by Messrs. John T. Thornycroft and Company, Limited, London, England, and is reported in the Sept. 27, 1946, issue of *Engineering*.

The need for such pressure variation arose, like some other innovations, from the requirements of the war. The vehicle concerned is the amphibious craft known as "Terrapin II," a flat-bottomed barge, with a watertight hull and eight wheels for land use, built by Messrs. Thornycroft. The variation of the tire pressure was required to suit the different conditions encountered when climbing out of the sea up a sand or shingle beach, or traversing a normal hard road. The land performance was found to be greatly improved by the adoption of the tire-pressure control system, a low pressure being used for traversing soft ground and a high one for hard ground. With the gear described, the driver has complete control over the tire pressure, through a wide range, while the vehicle is running.

The arrangement of the parts of the tire pressure-control apparatus can be best understood by reference to the layout diagram, Fig. 7. The incoming air, after passing through a suction filter *a*, is compressed in the compressor *b* and discharged through the pipe *c*. This pipe is connected to an unloading valve *d* from which a short pipe leads through the governor to the air reservoir *f*, in which the pressure is prevented from exceeding 100 psi by the combined action of the governor, unloader, and a safety valve *g* on the reservoir outlet. A cross-connection from the outlet to the unloading valve has a check valve *h*. The air from the reservoir is led by the pipe *i* to the control valve *j* near the driver's seat. From the control valve two pipes, *k* and *l*, lead aft to the tires. The pipe *k* supplies pressure air to pistons actuating separate control valves for each wheel, these piston and valve assemblies being indicated at *m*. The pipe *l* supplies air pressure to the tires themselves, the amount of air being regulated by movement of the piston-operated control valve. The main control valve *j* has a connection to a pressure gage *n*, while there is another gage *o*, which indicates the pressure in the reservoir outlet pipe *i*. The detail indicated at *p* is an air-operated whistle, the supply being taken from the pipe *i*.

The main control valve *j* is operated by a single lever which has five positions, as indicated in Fig. 7. The vertical position marked "Off" is the neutral position, that is, the air is retained in the tires without change of pressure when the lever is in this position. Should the driver wish to increase the pressure in the tires as he leaves a soft surface for a harder one, he moves the lever over to the left to the position marked "Inflate." This movement admits pressure air to the pipe *k*, the control valve *m* is opened, and the pressure air in the pipe *l* is delivered to the tires. Although the hardness of the tires can probably be judged from the running of the vehicle, the driver is not dependent solely on his judgment since he has only to move the main control lever a little farther to the left, into the position marked "Pressure Test," to obtain a correct reading on the gage *n*. Movement of the lever to the "Off" position when satisfactory hardness has been obtained, maintains the tire pressure constant by cutting off further supplies. Conversely, when the driver desires to obtain appropriate tractive effort on soft ground, he moves the main control lever to the "Deflate" position on the right. This movement is followed by admission of pressure air to the pipe *k*, and the control valve *m* is again actuated. A different condition, however, is set up in pipe *l*, pressure air being no longer admitted to it, but communication with the atmosphere, through the control valve, being established. In this way, the tire pressure may be lowered as required and the hardness again checked by movement of the control lever to the right into the deflating "Pressure Test" position. The pressure in the reservoir *f* and the supply pipe to the main control valve is, of course, always indicated on the gage *o*. Under normal operating conditions it has been found generally more convenient to keep the air compressor running continu-

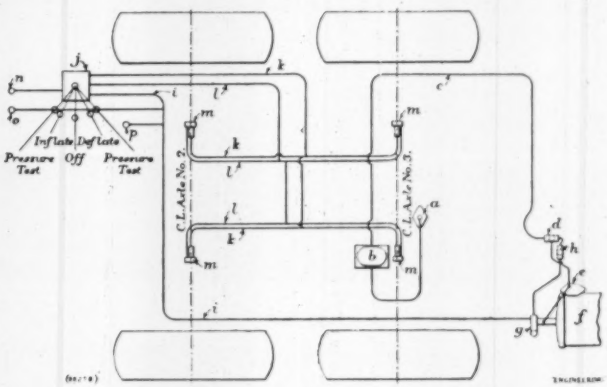


FIG. 7 DIAGRAMMATIC LAYOUT OF TIRE PRESSURE-CONTROL APPARATUS

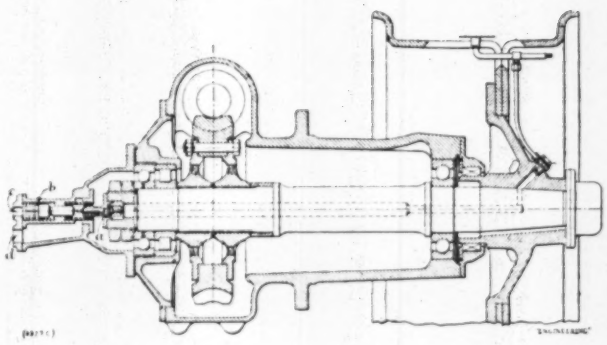


FIG. 8 CROSS SECTION OF WORM DRIVE AND CASING, AXLE, AND WHEEL HUB AND RIM

ously, but a lever near the driver's seat enables it to be disengaged if desired.

Fig. 8 shows a cross section of the worm drive and casing, the axle, and the wheel hub and rim. There is a separate axle for each wheel and communication with the tire-tube valve is made through a central hole through the axle and a pipe from the hub to the rim. A special form of tube valve, suitable for the pressure involved, is fitted, and the connection provides means for enabling individual tires to be inflated or deflated by, say, foot pumps, should the necessity arise, or the pressures to be checked independently of the control system.

Engineered Fabrics

FABRICS are being designed more and more with built-in characteristics for specific uses relates an article in the October, 1946, issue of the *Industrial Bulletin* of Arthur D. Little, Inc. Much of the current development in the design of fabrics stems from research sponsored by the Quartermaster Corps to meet military requirements and involves the use of synthetic resins and other chemicals. Profitable production of engineered fabrics will require extensive industrial co-operation; the textile processor must be educated in many of the techniques of the chemical industry.

The fabric improvement most desired by the consumer is one that will prevent shrinkage. A recent survey revealed that 80 per cent of department-store buyers ask for washable wool. The Army saved over $1,500,000 a month by shrinkage control of woolen socks for soldiers. The extra cost of shrinkproof fabrics to the individual consumer is only a small part of the price.

Wool is believed to shrink, at least in part, because, once the fibers are drawn together mechanically when wet, the scales on the fibers prevent their being pulled apart again. One method of shrinkproofing involves treating the surface of the fiber with resin to prevent the scales from catching on each other. Cotton shrinkage is not thoroughly understood either, but one theory is that its water-swollen walls collapse as the moisture content decreases; by filling up the fiber's hollow core with resin while the fiber is swollen, the collapse is prevented, but the external appearance of the fiber is unchanged.

The most common resins for shrinkproofing cotton and synthetics are the urea and melamine formaldehyde compounds. A process has recently been announced for treating rayon fabrics with glyoxal, a synthetic chemical, to stabilize them against shrinkage and stretch. For wool, the melamine resins are preferred because they reduce felting of the fibers and thereby preserve the open weave of the natural wool, even after it is washed. This makes possible a light fabric in which "dead-air" spaces prevail. Garments made from such material are lightweight and cool in summer, since they allow evaporation and insulate the body from the greater heat outside, yet they are warm without excessive weight in winter.

Resin treatment of spun-rayon fabrics also reduces their tendency to wrinkle and crease; this treatment is widely used in the industry today. More work has been done on crease-proofing fabrics in England, however, than in the United States. It has been estimated that 90 per cent of English rayon fabric is now crease-resistant, as compared with only 20 per cent in this country. The English climate no doubt has been an important factor in this development.

Sometimes "outer" impregnation of the fiber is sufficient, especially in fabrics where stiffness is desirable, such as glazed chintz or organdie. For this purpose, permanent finishes have been developed to replace nondurable finishes like starch. Glazed chintz which can be washed, and sheer fabrics which remain crisp for their entire life, will be on the market as soon as the textile situation eases. If current work is successful, even ironing will be eliminated, a boon to housewives who want ruffled curtains.

Pigment-resin dyeing has been accepted practice by the Army for fabrics for use in parachutes, mosquito netting, camouflage strips, etc., since 1939, although it has not completely replaced vat dyeing. The various processes have been improved during the past few years and are now well adapted for light colors. Since heat-curing makes the resin insoluble and results in fast colors, and since the process speeds up the printing and dyeing of fabrics, it is expected to be used to a greater extent in the future.

Many other chemicals are being developed to impart special properties to fabrics. Chlorinated paraffins, ammonium sulfamate, and antimony oxides are used for flameproofing; copper naphthenate, chlorinated phenols, mercurial compounds, and organic fungicidal compounds for mildew-proofing. Moth protection may be obtained for the life of an article with compounds permanently anchored in the fabric. Silica derivatives, which increase the frictional resistance between fibers, are now on the market. Applied to women's stockings, for instance, these compounds reportedly will decrease runs, since the yarn is not twisted as much for the same tensile strength and the friction prevents the stitches from slipping. Used with cotton yarns, they permit production of a softer more bulky fabric with less material.

There are many materials to make fabrics water-repellant; the older ones, such as metal salts or wax emulsions, must be applied whenever the garment is laundered or dry-cleaned. Newer compounds, classified as ammonium salts, break down on heating to other products which are said to be substantially permanent, in that they withstand laundering and dry-cleaning for some time.

Another new compound, a silicon derivative, which may be applied in gaseous or other forms, is said to resist normal washing and dry-cleaning The gaseous treatment, however, evolves hydrogen chloride, which must be removed to avoid tenderizing the fiber.

A recently announced process permits the use of shorter-staple cotton fibers hitherto considered unsuitable for textiles, and is said to result in a fabric as strong as one using higher-grade cotton and conventional methods. The short fibers are placed under equal and controlled tension, so that each individual fiber bears a portion of the load. By impregnating the fibers with resin so that they lock while curing, without the usual twist, a strong firm yarn is produced, suitable for canvas, rope, and other heavy-duty applications. Other processes involve mixtures of short cotton fibers with resins or heat-softening resin

fibers. Heat-treating causes the resin fibers to lock with the natural ones to form a heavy strong yarn.

All the resin processes require a great deal of expensive equipment. Drying and curing chambers alone cost about $30,000 to $40,000. Rayon finishing plants are now generally so equipped, but many other branches of the industry are not. The transition stage is a difficult one for the textile manufacturer, because the choice of suitable resins and proper curing of them are crucial operations. Since each treatment has its individual characteristics, the choice of a particular treatment and the establishment of a treating routine pose greater problems for the textile industry than does use of the traditional finishes.

Friction Sawing

HAND friction sawing, according to an article by H. J. Chamberland, in *Western Machinery and Steel World*, August, 1946, has in a remarkably short time become recognized by the metalworking industry as the most promising cutting technique since the discovery of metal carbides.

With friction sawing, unlike conventional sawing or any other machining operation coming under the heading of chip production, the degree of Rockwell hardness and sharpness of saw teeth are not determining factors to cutting efficiency. As a matter of fact, high-speed steel milling cutters are now being salvaged by friction-sawing by cutting through a 3-in. diametrical section of teeth in less than 25 sec. Still more strange is the almost unbelievable reality that a new saw band reaches its peak of efficiency only after cutting from 20 to 30 min; in other words, sharp teeth do not create friction but rounded cutting edges do.

"Friction" and "high velocity" sawing should not be confused; the latter still remains an actual but improved band-sawing technique whereas sawing by friction means softening the metal in the kerf to a plastic state, and hence the reason why the saw advances so rapidly through the material being cut.

Aluminum, magnesium, brass, copper, zinc, lead, and the like cannot be friction-cut due to their extremely low melting range. On the other hand, most steel alloys are within the proper melting range and lend themselves readily to the friction-sawing process. Other very profitable friction-sawing applications are ferrous castings, all S.A.E. sheet metal and steel plates, and particularly the stainless steels and armor plate.

Friction sawing is accomplished with standard pitch bands varying in width from $\frac{1}{2}$ to 1 in. depending on whether or not a radius or curve is involved and its dimension. It is, however, very important that the band be of the highest quality available, particularly so in respect to correct depth of tooth hardness, which means a long-life saw even when exposed to the severe strains of friction-sawing.

The reason why an ordinary saw band, that is, the hardened teeth, can stand the excessive heat generated by friction and not crumble is because the section of the blade doing the actual cutting is only in contact with the material being cut for a small fraction of a second, hence the small amount of heat generated is readily dissipated, as the 255-in. band circles around, and this accounts for tooth fitness being retained virtually for the duration of saw flex life.

The softening characteristics of steel are changed from low to high, or vice versa, as alloying elements are added to the iron; it is obvious therefore that the heat requirements at the point of contact between saw teeth and material must be varied accordingly. In the first place, it is necessary to select a saw having the correct number of teeth per inch suitable for the thickness of cut involved. Widely spaced teeth have a tendency to remove material faster than it can be softened; too close a tooth spacing will cause loading. Secondly, a wide variety of speeds is required to offset increase in thickness of material, which means additional heat must be generated.

A point to bear in mind in connection with friction sawing is that the saw speed must increase as the thickness of material increases. This is of course contrary to actual sawing procedure, where saw speed must be reduced not only as the thickness increases but the degree of hardness as well.

It can be said that saw life varies considerably, since it all depends on the nature of cut. For instance, in cutting the thinner materials virtually no stress in feeding pressure is exerted on the blade and it will therefore stand up for about three days of efficient cutting unless the material is extra hard or the operation is one of contouring. A heavy work section having extreme ductility will expectedly shorten saw life to some extent. This is particularly true of silicon-coated castings.

Generally speaking, plastics are not friction-sawing applications although actually cut at friction-sawing velocities for $\frac{1}{4}$-in-thick carbon, free-machining, nickel, and other steels. The process applies only to some thermoplastics and particularly those compounded with glass, mica, or any other abrasive substance.

The stainless steels, heretofore a real cutting problem, respond most efficiently to the friction-sawing process.

Pipe and tubing are both economical friction-sawing applications but present a somewhat different cutting problem from flat stock on account of cross-sectional variation. Friction sawing in this respect is limited to a certain wall thickness per given diameter of pipe or tube, a $\frac{1}{4}$-in. wall thickness for a $1\frac{1}{2}$-in. diameter, and a $\frac{1}{32}$-in. wall thickness for a 12-in. diameter are considered maximum dimensions, respectively, to which friction sawing should apply.

A more detailed report on friction sawing together with factual data on specific jobs is given in "Metal Cutting Data" for October, 1946, published by The American Society of Mechanical Engineers.

Aircraft X-Ray Studies

MILLIONTH-of-a-second x-ray pictures now are being used to study the bodily distortions a flier endures when he makes a crash landing or is catapulted out of a crippled speed plane, a Westinghouse scientist said recently, according to the September, 1946, issue of the *Journal of The Franklin Institute*.

Army and Navy aero medical laboratories have ordered x-ray units to obtain visual evidence of what happens to the pilot's spine, heart, and other organs while his body is jolted by the sudden and terrific stops and starts involved, Dr. Charles M. Slack told the Connecticut Valley Section of the American Industrial Radium and X-Ray Society.

"In crash landings, for example," the scientist explained, "fliers undergo a shock equivalent to 10 times the shock to a motorist if he could halt his automobile in one second from an 85-mph speed. Body harnesses have been devised to cushion such deceleration blows but the strain on organs still poses a problem."

By simulating actual flying and crash conditions in the laboratory, x-ray studies of the body can be made while the body is subjected to strains. Sequence photographs can be arranged to show the step-by-step distortion of the organs, which are stopped dead by millionth-of-a-second exposures.

Jet-age planes are breaking old speed marks so fast that the Army Air Forces recently predicted that future planes would be zooming through the air at 1000-mph speeds, 300 miles faster than the speed of sound.

If a man tried to climb out of a supersonic plane whose motor failed, he would be cut to ribbons by the wind, so a mechanical arrangement has been devised to literally fire him out of the airplane simply by pushing a button. The high accelerations necessary to get the pilot out so he can parachute to safety give his organs a jolt 20 times as severe as the normal pull of gravity.

X-ray study of ejection-seat "body bending," as well as studies of the proper amount of explosive force required to fire pilots out of the cockpit, are included in the aero laboratory investigations.

The study of bodily distortions is the most recent of a number of unusual applications in the medical ballistics and industrial fields for the x-ray unit using the tube, which was developed in the Westinghouse Research Laboratories five years ago by Dr. Slack and his associates.

The unit was used during the war for experiments in connection with the atomic bomb as well as for studies of shells, bullets, and armor plate. Peacetime possibilities include the study of swiftly-moving machine parts while they are in motion.

The speedy exposures—20,000 times as fast as the normal exposure for routine medical x rays—are accomplished because of a special electronic tube which operates under high momentary voltage. When this voltage is applied electrons speed at approximately 100,000 mps in their flight from the tube filament to the anode "target" at which the electrons are aimed, pouring an x-ray barrage through metal to make the picture.

Russian Industrial Development

AN intensive program of Russian industrial development in the Urals is revealed in an article by G. Vorobyov appearing in the September, 1946, issue of *The Engineer's Digest* (London). The Chkalov region (formerly Orenburg province) which occupies a large part of the southern Urals and the Caspian lowlands, was a predominantly agricultural region in the past Prospecting conducted during prewar years brought to light deposits of gold, oil, coal, shale, nickel, copper, iron-ore, and other minerals in this region. Realization of these plans has completely changed the economic aspect of the region where large industrial enterprises have been built. Extraction of oil commenced eight years ago near Buguruslan in the northwestern part of the Chkalov region. Since then the Buguruslan Oil Trust has advanced to a leading place in the "Second Baku," i.e., the system of oil fields situated between the Volga and the Urals. During the last five years this trust has effected a ninefold increase in the production of oil.

Seven years ago the copper and sulphur works at Mednogorsk and the nickel works at Orsk which receive ore from the rich Bliavinsk deposits were put into a machine-building center. A modern meat-packing plant and an oil refinery which receive oil from Guryev on the Caspian shore along a 500-mile pipe line, have been built in Orsk.

Maps published eight years ago do not show the new industrial centers of Mednogorsk and Novotroitsk which now stand in the former barren steppe districts.

The significance and importance of the region's industry increased during the war. Fifty-three new enterprises were built during the last five years and the number of workers occupied in industry increased 2.2 times. The region's industrial output in 1944 was 32 times the total volume of the production in Orenburg province in 1913. The new plan for 1946 to 1950 provides for the further development of the iron, steel, and nonferrous-metals industries and also machine-building and oil production in this region.

The southern Urals heavy machine-building plant whose construction is to be completed in 1947 will produce equipment for open-hearth and blast furnaces, rolling mills, overhead cranes, and blooming mills. This machine-building colossus is already supplying rollers for blooming mills and cooling plates for blast furnaces.

The Orskkhalilov iron and steel mills now under construction will use iron ore discovered near Orsk fifteen years ago. This ore contains a large proportion of chromium and nickel. The steel mills will produce natural alloys of high-grade pig iron and rolled metal. It will have four coking batteries, as many blast furnaces, seven open hearths, three bessemer converters, a blooming mill, a powerful rolling mill, and a power station. Production will equal the total output of the iron and steel industry of the Urals during the tzarist period. A large reservoir and a 30,000-kw power station are being built on the Ural river to secure an adequate water supply to the Orskkhalilov mills.

Large investments will be made into the oil-refining industry whose output is scheduled to increase several-fold by the end of the five-year period. It is planned to reconstruct and double the size of the machine-tool plant in Chkalov and to build two plants for the production of forge-shop equipment and fixtures

The Kuibyshev machine-building plant was built in Buzuluk between Chkalov and Kuibyshev (formerly Samara) during the war. This plant will be expanded during the coming five years when it will add a forge shop, foundry, and assembly shops. Buzuluk will also receive a new plant which will produce machinery for Ministry of Food Industry.

Considerable funds will be spent on the reconstruction and extension of the Orenburg railway. New lines will be built from the station of Sara eight kilometers to the west of Orsk to Magnitogorsk and from Chkalov to Ishimbai, en route to Ofa, capital of Bashkiria. Double tracking will be laid on a considerable section to the east of Orsk, and the Kuibyshev-Magnitogorsk railway will cross the Chkalov region which will be converted into one of the most important industrial regions of the U.S.S.R.

Contact Arc Welding

THE great difficulty in free arc welding has always been in maintaining the arc. The welder must continually take care that the distance between electrode and workpiece is only a few millimeters and that it remains constant.

When the distance is too small the rod "freezes" to the workpiece, that is, the solidifying drops form a rigid connection. When the distance is too large, the arc burns irregularly and the quality of the work suffers, and with alternating current there is much chance of the arc being extinguished.

In the course of years, however, it has been noticed that with certain types of electrodes the coating can rest on the workpiece during the welding; this is called touch welding.

It was found that this procedure was possible only with heavily coated electrodes. This can be understood, when one considers that in welding with a rod with a thinner coating only a short cup is usually formed around the arc. When the edge of such a cup is allowed to rest on the workpiece, the drops of metal flowing from the core wire short-circuit and freeze the rod to the workpiece.

If one tries to determine the relation between the thickness of the core wire and that of the coating necessary to prevent this, it is found that it depends upon various factors. If we assume that the welding is done at an angle of 45 deg to the workpiece and that the cup is formed at an angle of 45 deg to the axis of the electrode, we see from Fig. 9 (*a*) that the relation between the size of drop of the molten metal and the dimensions of the cup is such, for instance, with the electrode type Ph 50, that touch-

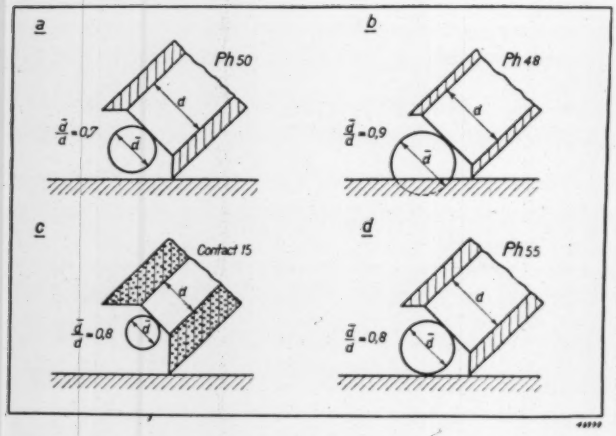


FIG. 9 DIAGRAMMATIC REPRESENTATION OF THE POSSIBILITY OR IMPOSSIBILITY OF TOUCH-WELDING FOR DIFFERENT TYPES OF ELECTRODES

welding is just possible, while with type Ph 48, see Fig. 9 (*b*), it will be quite impossible.

From this the conclusion might be drawn that to make touch-welding possible it would be sufficient to give the electrodes a heavy coating. Not only would this, however, be an expensive method but at the same time difficulties would occur in the welding because of the larger amount of slag.

Fig. 9 is only a rough sketch; for instance, the formation of the crater (a small dimple in the workpiece underneath the arc) has been disregarded. When high currents are used this crater is rather deep and in that case touch-welding with electrodes of type Ph 50 and 55 easily succeeds. It has never been possible to arrive at a general application of touch-welding because of the limitations just mentioned and some others.

For these reasons, research work was carried out by Phillips in their laboratory with the object of perfecting the properties necessary for touch-welding, to such a point that welding could be done with much less trouble and that practically no errors could be made in welding. This includes the requirement that the weld bead should have a flat and uniform appearance. The investigation has now led to a new method of welding called "contact arc welding" and is described by P. C. van der Willigen in the June, 1946, issue of *Phillips Technical Review*.

The method makes use of a newly developed electrode which is in continuous contact with the workpiece, so that welding can be done by dragging the rod over the workpiece.

In Fig. 9 (*c*) it is indicated diagrammatically that, with electrode contact 15, touch-welding should be quite easy. The external diameter of the electrode is more than twice the diameter of the core, so that the coating is extremely heavy. For the sake of comparison an ordinary electrode Ph 55, which has the same external diameter and the same weight is shown in Fig. 9 (*d*). These two electrodes deposit the same amount of iron in the same time.

With the contact electrode the ignition of the arc has become much easier. It is not done in the usual way by tapping and breaking off the cup, but entirely automatically. This simplification in starting is closely connected with the new composition of the coating.

In the development of the contact electrodes, much metal has been transferred from the core to the coating. When the amount of metal transferred to the coating is approximately the same as that remaining in the core, the conductivity of the coating is found to have become so high that when the coating, under tension, is brushed over the workpiece sparking occurs, such as takes place from the trolleys or shoes in electrical traction when there is icing. A current is then flowing of the order of magnitude of 0.1 amp. When the coating is not brushed over the edge, but is held against a definite spot on the workpiece, the current will rise rapidly and at a value of about 1 amp will suddenly pass to an arc; the welding arc is then automatically ignited. The arc is usually ignited within one second. When in the hot condition, ignition takes place even more quickly, and obviously the voltage applied also has some influence on the speed of ignition.

Thus the contact electrode has been made self-starting. Not only has it become unnecessary for the welder to start by tapping, but the reignition, after an interruption of a few cycles, also takes place automatically.

The advantage of contact arc welding therefore lies in the possibility of easy touch-welding and the automatic ignition and reignition of the arc. Moreover, with a given current the amount of metal deposited per unit of time is considerably greater.

It is reported that these new contact electrodes are not only suitable for contact arc welding, for which purpose they were developed, but that they also offer important advantages for welding with the free arc. The contact electrode gives much less extinguishing of the arc, even when the open voltage of the welding transformer is lower than normal. This is probably the result of the great conductivity of the coating, which now and then touches the pool when the cup is so long.

It is easy to weld with the contact electrodes, due to the ease of touch-welding and the self-starting. If one must start at a precisely fixed point it is a great convenience if the starting is automatic, especially when using holders with a push-button mechanism. The welder places his electrode tip on the predetermined spot, puts the shield before his eyes, and presses the button. It is a great convenience for beginners since there is no longer the trouble of tapping and striking the arc.

Practice, however, is necessary in order to maintain the proper distance between core and workpiece when welding with the free arc, and it is found that this even presents difficulties for experienced welders, when welding has to be done in difficult positions, so that they, too, may then have trouble with freezing. With the newly developed electrodes, however, the coating has been made so thick that the cup of the rod is always deep and strong enough to keep the core in touch-welding at such a distance from the workpiece that it cannot freeze.

The mechanical properties of the material deposited by these new electrodes are found to be similar to those of the corresponding normal electrodes.

Condensing Locomotives

GERMAN-developed Henschel condensing locomotives, capable of making a 600-mile run without replenishing their water supply are described in a report (PB-19581) now on sale by the Office of Technical Services, Department of Commerce. Since the tenders are equipped for condensing and recovering exhaust steam, water loss is comparatively low.

Early models of Henschel condensing locomotives were sold to the Soviet Union and Argentina before the war, according to the report. Their use in Siberia and the Far East were reported to be favorable, and the German State Railways ordered several of the locomotives in 1942.

The Henschel condensing locomotive operates as follows: Exhaust steam from the two cylinders is fed to the blower turbine on the left side of the smokebox. From this turbine an exhaust-steam pipe runs on the left side of the locomotive to an oil separator, and thence to the fan turbine located on the

tender. In its course the pipe receives exhaust steam from the feedwater pumps, the air compressor, the headlight turbo-generator, and boiler safety valves. Finally, the steam is piped into the condenser-cooling elements fitted to both sides of the tender.

The condensate is stored in a collector below the tender bottom, and the water is fed to the locomotive boiler. The cooling air for condensing the steam is supplied by the fan turbine. The condenser operates without a vacuum.

Silicone Rubber

INCREASING use of silicone rubber for industrial products demanding a material that will withstand a wide range of operating temperatures has resulted from improved molding and fabricating techniques developed by the General Electric Company's Chemical Department, Pittsfield, Mass.

Used primarily as gaskets for searchlights, superchargers, and other electrical equipment in extruded form during war years, the silicone material is not only being more widely applied in those fields but is finding comparatively extensive use in aircraft, heat-sealing equipment, various types of lighting equipment, baking ovens, Diesel engines, and vacuum systems, in both the extruded and molded forms.

Possessing heat resistance to a degree that it remains practically unaffected when subjected to temperatures ranging from minus 55 F to plus 520 F, silicone rubber also is highly chemical- and moisture-resistant and provides excellent electrical insulation. In addition, it will not adhere to metals or other materials at high temperatures, which is important when applied as gasketing material.

It is reported that silicone rubber withstood continuous use in searchlights at 340 F as compared to a generally accepted maximum of 220 F for most synthetic and natural rubber formulations. Severe tests in which silicone rubber aged for one year in a hot, dry, circulating oven did not appreciably change the surface hardness or flexibility of the material. At a temperature of 400 F, the silicone material remained flexible and resilient for several months and at 500 F for several days.

It is also reported that silicone-rubber parts are now being used in many large aircraft as gaskets in powerful new radial-engine motors and jet engines; and it is being incorporated in a new type of oil seal which operates around high-speed shafts

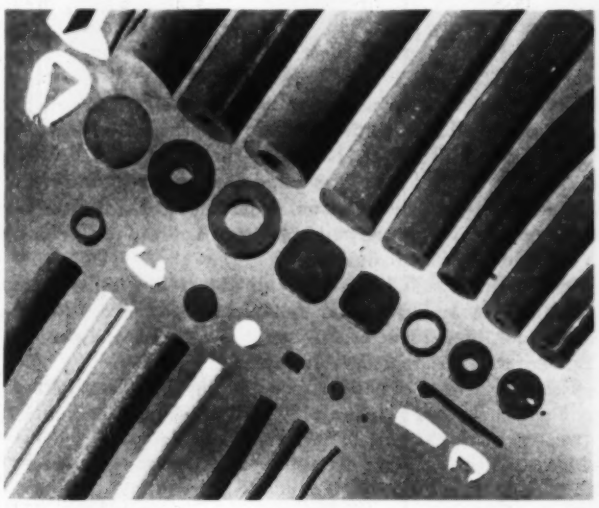


FIG. 10 SAMPLES OF EXTRUDED TUBES, RODS, AND FABRICATED STOCK MADE OUT OF SILICONE RUBBER

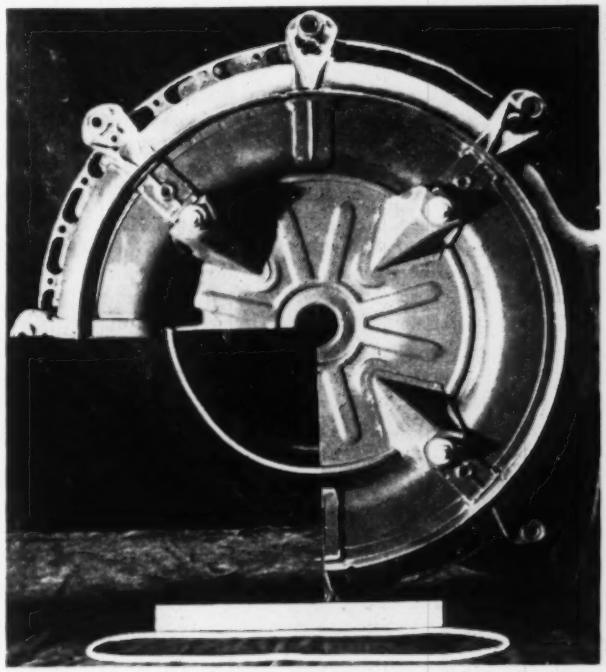


FIG. 11 ILLUSTRATION OF USE OF SILICONE RUBBER AS GASKETS IN AIRCRAFT SUPERCHARGER

at temperatures of 350 to 400 F. The outstanding heat-resistance of the material also suggests its use in hot-air deicing systems, heating ducts, and other places in the planes where high temperatures are encountered.

In high-vacuum systems, it is claimed that silicone-rubber gaskets do not harden and crack due to the escape of volatile plasticizing components at elevated temperatures because of the absence of any plasticizing oils in the formulations. The fact that they maintain uniform surface hardness and flexibility over a wide range of temperatures is important as well as the fact that there is less breakage of glass equipment occurring from expansion and contraction when silicone rubber is used between glass and metal at high temperatures. For this application, the silicone product also gives greater protection against leakage because stocks do not harden and less pressure is necessary with the softer stocks to obtain a good seal.

One of the increasing uses for silicone rubber is as gaskets in high-temperature equipment such as Diesel engines, gas turbines, air compressors, and other equipment where natural and synthetic rubbers cannot withstand the high operating temperatures and have too-high permanent-set characteristics. In the new Diesel-electric locomotive, silicone-rubber gaskets are used between the supercharger and Diesel-engine block where a soft resilient stock is required to give positive gasketing action at 300 F and 15 psi air pressure. It was stated that the heat resistance of the silicone material results in few replacements of gaskets and reduces time lost due to repairs.

Another use of silicone rubber is as a press pad in heat-sealing equipment where it stands continued exposure at 300 to 350 F with no noticeable change in flexibility or surface hardness and will not adhere to plastics, glass, cloth, metal, and other materials used in packaging. A similar use is in the pressing of sheet mica where silicone rubber is laminated with layers of asbestos cloth to provide a pressing pad that insures an even bond over the entire sheet.

It is disclosed that the silicone material is receiving additional use in the lighting field as gaskets for floodlights, searchlights,

explosionproof lamps, hospital operating lamps, and infrared baking equipment. In such applications, the use of silicone rubber reduces possible breakage of the lens because of its resiliency at high temperatures and likewise reduces maintenance problems due to the fact that no volatile components which coat the lens are given off at high temperatures. It is also reported that silicone gaskets oftentimes eliminate expensive cooling vanes and other design considerations given to reduce temperatures. High intensities of light do not promote surface oxidation and cracking and, when relatively high concentrations of ozone are present, stability is excellent.

For high-temperature baking ovens, silicone-rubber gaskets result in less frequent shutdown of baking equipment; less entry of air or leakage of hot air because of the uniformity of the material at varying temperatures; and less necessity for close tolerances to be held on the doors of large ovens because of the soft stocks available.

It was disclosed that the use of silicone rubber in home lighting fixtures and as gaskets for refrigerators is being investigated, because there appears to be no tendency for the silicone rubber to stain the metal or wooden parts with which it comes in contact. Under similar conditions, natural or synthetic rubbers tend to discolor such surfaces and also harden and crack on the surface due to the effect of the oxygen in the air. Silicone-rubber parts exhibit excellent resistance and are expected to remain soft and resilient for years.

Silicone rubber is available in extruded shapes, molded parts, sheet stock, or fabricated stocks. Extruded rubber is available in rods, tubes, flat strips, or a large variety of desired shapes for which a die may be formed. Sheet stock is available in thicknesses from $^1/_{32}$ in. to $^3/_4$ in. and also may be reinforced with plies of glass and asbestos cloth to give greater strength. Molded parts can be made in any of the conventional types of compression molds and are now being produced in increasingly intricate shapes. Silicone-rubber-coated glass cloth is also available.

Aluminum Roofing and Siding

AN explanation of the factors involved and recommendations for applying aluminum roofing and siding has been detailed by J. S. Pollack, Building Products Division, Reynolds Metals Company, Louisville, Ky. Some of the high lights from his discussion should prove interesting to those who intend using aluminum materials for building purposes.

Properly applied, aluminum roofing and siding can be depended upon to provide a weatherproof and fireproof covering that will last as long as the building structure itself. More and more aluminum is going into roofing and siding because of the metal's many inherent advantages in this application.

Its light weight means that lighter supporting structures can be used. This factor means speedier easier erection. Its nonrusting quality eliminates the need for paint at any time to prevent disintegration from rust, because rust—the great enemy of common metallic roofing and siding—is not involved with aluminum. This elimination of frequent and costly maintenance can be an important source of savings.

An added important feature is that the high reflective surface of aluminum turns back much of the sun's heat to provide lower temperatures inside the structure, equivalent to the use of considerable insulation.

The most important factor involved in erecting aluminum roofing and siding is proper insulation to avoid deleterious electrogalvanic action.

This is relatively simple to avoid because, for it to occur, one must have two dissimilar metals in contact. Any means of avoiding actual metal-to-metal contact at those points where moisture collects will protect against this action. This can be done by providing a protecting sleeve or saddle of aluminum to cover the steel at point of contact; by use of a nonconductor such as building paper; or by painting with aluminum paint which then provides an aluminum-to-aluminum contact at the moisture-collecting point between roof and support.

The second important factor in proper erection is to assure a good seal around the opening made in fastening the sheet to its supports. Every method used in joining the sheet to the supports involves making a hole through the sheet itself. Unless the fastening affords a good seal at this point, deterioration of the roof and possible damage to the contents of the building are inevitable.

For this reason, the most highly recommended application methods make provision for effectively sealing off the hole made in fastening. Sealing can be done by use of rubber washers under nail, screw, or bolt heads; by use of washers made from zinc-chromate impregnated tape; and by application of roofing compound over the fastening.

Many applications of corrugated roofing sheets will be over sheathing which will in turn provide the support required to uphold wind and snow loads. Aluminum roofing can however, be used without sheathing wherever the sheet has sufficient load-carrying capacity.

Loading charts serve as a guide in selecting the proper gage of aluminum for any particular application. Care should be taken in determining the maximum load value that the corrugated sheet must withstand in a given locality. It is evident that the man applying a roof in the northern section of the country must make proper allowance for maximum snow loadings that may be encountered. Building codes obtainable from local building authorities usually specify maximum roof loadings.

To prevent wind loads from pulling roofing sheets off the nails, aluminum washers may be used to distribute the stresses.

There are some general principles which must be followed in erection to obtain a good roof. The first sheet is always placed on the lower or bottom row at the opposite end of the roof from which the prevailing winds come. Then, as additional sheets are overlapped in laying the first row, protection from driving rains carried by prevailing winds is afforded by the side laps. Application is thus in single rows from eave to ridge, proceeding along the roof toward the windward end.

Second and succeeding rows of sheets are placed to lap over the preceding rows at the end A 6-in. overlap at ends is specified for all three types of sheet when used as roofing, and 4 in. when used as siding.

Corrugated sheets are always nailed through the top of a corrugation. The reason is that any rain running down the roof tends to collect in the bottom of the corrugation. Nailing at the top greatly reduces the amount of water that may enter around an imperfectly sealed nail hole since at the top the rain is running away from the nail hole instead of into it as it would at the bottom of a corrugation.

Roofs with insufficient slope will not drain properly and a driving rain may blow water up under the end laps. For this reason, a minimum rise of 3 in. per ft is desirable and the slope must never be less than $2^1/_2$ in. per ft.

The best method of nailing to sheathing is to use galvanized roofing nails about $1^3/_4$ in. long with a head about $^3/_8$ in. in diameter, nailing at 8-in. intervals along the length of the sheet. These nails should have a hot-dip zinc coating, not merely a plated coating, as this latter tends to chip off and so does not provide the protection afforded by the hot-dip zinc-coated nail.

In addition, a washer of nonmetallic material such as neoprene or other rubber should be employed under the nailhead.

Aluminum washers may also be used, especially where sheets are screwed to wood 2 × 4 girths and plain steel screws are the only type available. Placing an aluminum washer under the head of each screw will greatly improve the erection job and lengthen the life of the building.

Hot-dip galvanized nails may be used without washers when suitable washers are not available. Also roofing nails with cast-on lead heads can be used, provided the building is in a rural section away from industrial or seacoast atmospheres.

Cadmium-plated roofing nails, screws, and bolts may also be used since the cadmium surfaces in contact with the aluminum have little tendency to cause any deterioration from galvanic action. Nonmetallic washers are recommended, as with hot-dip-zinc galvanized nails.

The best method of applying corrugated aluminum sheet to steel purlins for roofing, or to steel girths for siding, is to use an aluminum straphanger. The straphanger is riveted to the sheet with aluminum rivets and washers. Rivets are usually $^3/_{16}$ in. in diameter. Straps are applied at approximately 12-in. intervals along the purlins or girths and are riveted to the top of a corrugation in each case.

Since condensation frequently occurs on the underside of the roof, it is at the point where the steel purlin is in contact with the aluminum sheet that protection against galvanic action must be supplied. The best method is to use an aluminum saddle. However, painting the top of the purlin with aluminum paint or bitumastic paint will also afford protection. Roofing paper can also be used to separate the two metals.

One of the most widely used erection methods involves the use of purlin clips. When received for use, the clips do not have the left leg turned down. In applying them, they are slipped over the upper flange of the purlin and then the left leg is hammered down, locking them securely in place. A soft aluminum washer should always be used under the bolt head.

Another useful method employs a single aluminum purlin nail with an aluminum washer. The nail is simply bent around the underside of the purlin to lock the sheeting in place.

While none of the recommended erection methods involves any great difficulty or expense, they are important in assuring the lifetime of use expected from a building roofed with aluminum. A small additional expense during erection is well worth the added years of life that proper erection methods guarantee.

Roof Cooling

ONE of the latest and most interesting methods of roof cooling and insulation is combined in maintaining a film of water on a dead-level-deck roof. An article in the July, 1946, issue of *Canadian Automotive Trade*, by Rowland Pepper, the managing editor, describes this method of sustaining a normal temperature during the hot months. The latest method of building a roof is to have it level, with a rim 1 to $1^1/_2$ inches high around it to hold water. Hoppers or drains carry away excess water. More water, if not in circulation, will not cool off overnight and maintains a heating surface which keeps temperatures up under the roof. Two inches of water is said to be equal to about four inches of many other types of insulation. Ice formation in wintertime provides as good an insulator as the water in the summer.

A water film on the roof provides a reflective surface to the sun's rays which keeps inside temperatures 12 to 15 deg less than without water. Even the beneficial results gained from saving the rain that falls on the roof are worth while. Rain kept on the roof and not drained off will last from four days to two weeks, depending on the depth of water.

Aside from the cooling effect gained from the insulating and reflecting qualities of the water, a considerable advantage is gained from the increase of roof life by some 50 per cent. Heat from the sun and other weathering deteriorates roof material and pitch very rapidly. The water film slows down this aging and prolongs roof life.

Where further and more effective cooling is desired a system of roof sprays and recirculated water can be installed It is found that when a spray is used the roof does not get warm and consequently does not transfer appreciable heat into the building.

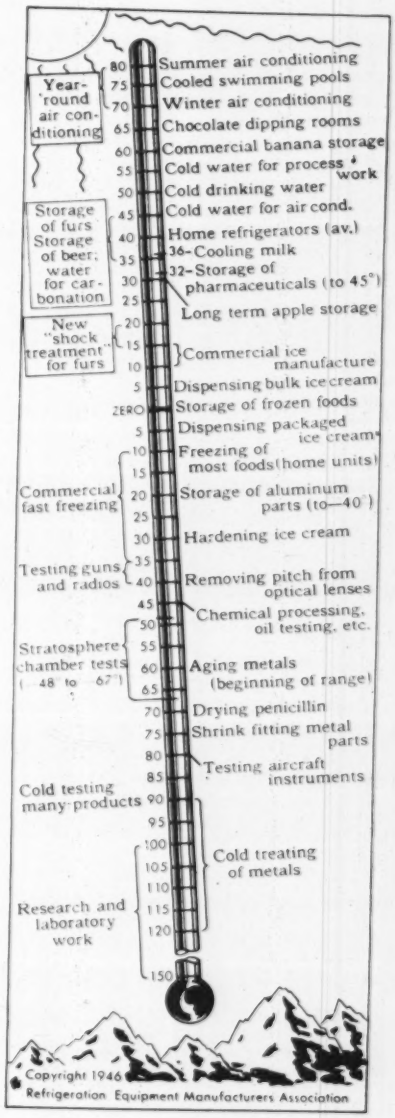


FIG. 12 ALL-INDUSTRY THERMOMETER

(In a recent survey of the services now performed by mechanical refrigeration and air conditioning, the Refrigeration Equipment Manufacturers Association listed more than 200 uses, ranging from air conditioning for human comfort in the above-zero brackets, to the 65–36-F below-zero span used in various food preservation and processing, on down to the subzero temperatures of 90–150 F below zero used in the cold-treating of metals and in research work. Typical uses in the entire 230-F range are shown.)

COMMENTS ON PAPERS

Including Letters From Readers on Miscellaneous Subjects

Better Papers Wanted

To the Editor:

This is a letter to complain about the character of some A.S.M.E. papers. I think they are too mathematical and not comprehensible to the average engineer.

A paper I heard at the Fall Meeting in Boston was all differential equations and, no doubt, was a scholarly demonstration. There was very little discussion. How could there be if few understood it? One is even led to suspect some deliberate ostentation—that the papers are sometimes written to show off the authors' mathematical ability.

I think an engineering paper must first and foremost give information of value to engineers. It must present this information in intelligible form. Business reports usually present the conclusions first—they do not present them at the end like the denouement of a detective story. An engineer who writes a report for a client (and hopes to write another) develops his argument in the simplest possible terms. He avoids language which is over the layman's head. He relegates mathematical derivations and tables to the appendix. He depends on simple graphs and charts to illustrate his points.

Few established engineers can remember advanced mathematics. It is seldom actually used in ordinary engineering work. It seems to me it would be far better for the average member of the A.S.M.E. to have papers written in the terms he can master than to have him feel that there is hardly any use reading or hearing certain papers. I think the proper place for presentation of the mathematical paper is before a scientific society; especially the type of paper that is solely concerned with a mathematical derivation of a formula.

The engineer is not primarily a scientist. He is primarily a businessman trying to make money (although usually for someone else). The engineer seldom has time to be put through all the paces of a mathematical analysis of a problem, nor has he, as a rule, the capacity for understanding the more involved steps. His needs will involve the use by fairly simple methods of what the scientist has developed—usually his mathematics will consist of nothing more than arithmetic. The real engineering contribution is not the rigorous mathematical solution, but the method of approximate solution by short cuts and simplifying assumptions. In other words, the engineer wants to know how to do it the easy way. Many A.S.M.E. papers seem to be telling us how to do it the hard way.

The increase of knowledge in the world will not be furthered by suppression of papers of a highly mathematical nature. Such papers could, however, be kept in special sections of the Transactions so the less erudite members would know enough to stay away. It would not be necessary to actually post the warning, "Abandon hope, all ye who enter here."

Can we not try to formulate rules which will bring technical papers to the level of maximum usefulness to the average engineer? A little more detailed explanation in layman's language, avoidance of deliberate erudition and presentation according to the best business practice will, I think, increase attendance and stimulate discussion of Society papers.

Charles T. Chave.[1]

[1] Mem. A.S.M.E.

Locomotive Boilers—Welded Construction

Comment by J. G. Adair[2]

With reference to the information contained in this paper,[3] except for some special jobs, the saving in weight may not be of any great importance since it is desirable that locomotives have a sufficient factor of adhesion to avoid excessive slippage of the driving wheels. Increasing of boiler pressures was practiced by a considerable number of railroads during the late war in efforts to obtain greater locomotive power; this, in turn, reduced the factor of adhesion of hundreds of locomotives to the point where many of them became chronic "rail burners." Shortages of rail for replacement of the engine-burned rails resulted in slowdowns of traffic and gave the engineering officers and maintenance-of-way men many headaches. There is room for reasonable doubt as to whether the war effort was furthered by these increases of boiler pressure without the addition of ballast to the locomotives to obtain corresponding increases in weight for adhesion purposes.

It is understood that the approximately 300 partially fusion-welded boilers referred to by the author were for a foreign government and not for use of the U. S. War Department. This order originally contemplated riveted boilers, but prompt delivery being essential, representatives of the country where the boilers were to be used finally agreed to the building of the boilers as described because of the then existing overload on the hydraulic riveters. The writer has been informed that delivery was on time; for all of which the author's company is to be congratulated. This accomplishment, great as it is, takes its place as only a minor part in the miraculous performance of this company in helping our war efforts.

In that part of the paper referring to the Bureau of Locomotive Inspection not sanctioning the use of the different designs of attachment outlets, such as manholes, which are shown in the codes for unfired pressure vessels and for stationary boilers, the author has apparently inadvertently used the word "manholes" instead of the words "steam domes" and "nozzles." No indication has ever been given by the Bureau that it will not agree to the manhole assemblages contemplated by the codes. The author undoubtedly intended to refer to the refusal to sanction the use of steam domes attached in a manner shown in the codes for one of the various types of nozzle openings authorized therein, which is merely an outlet or steam-pipe connection to the shell and which does not require an opening in the shell in any way comparable to the size of opening required for a locomotive-boiler steam dome or a manhole. This particular type of nozzle outlet has

[2] Mechanical Engineer, Bureau of Locomotive Inspection, Interstate Commerce Commission, Washington, D. C. Mem. A.S.M.E.

[3] "Locomotive Boilers—Welded Construction," by James Partington, Mechanical Engineering, vol. 68, 1946, pp. 622–624.

in some instances been increased in dimensions to manhole size in unfired pressure vessels with disastrous and expensive results when failures occurred at the manholes. There is therefore no assurance that similar failure and results will not occur with locomotive boilers if equipped with like nozzle assemblages of manhole or dome-opening proportions.

The author predicts that one of the next forward steps will be bracing attached by welding before the boiler shell is stress-relieved. The current codes do not permit the attachment of braces by fusion-welding. If welded attachments are accepted by state and other authorities which enforce steam-boiler safety rules, increased confidence will thereby be indicated in the soundness of nonradiographed welds since welds joining the braces to the shell will necessarily be of the fillet type. Such welds are not commonly radiographed, as defects therein are not as readily determined by this means as in welds of the butt type.

COMMENT BY F. P. HUSTON[4]

The author has presented a historical sketch of the development of the welded locomotive boiler which is of particular interest to the writer who attended the early meetings of the A.S.M.E. Boiler Code Committee as a designer and fabricator of welded pressure vessels. In those days electric welding was done with bare-wire electrodes by welders as temperamental as prima donnas. Welders were rated good if the vessel could be moved from the welding floor to the test floor without a seam splitting open. Metal-arc welding was truly an art.

The hammer test under a hydrostatic pressure of $1^1/_2$ times the working pressure, followed by an application of twice the working pressure, gave a measure of assurance against subsequent failures from brittle welds.

The introduction of coated electrodes, procedure controls, welder qualification tests, x-ray examinations, and stress-relieving, together with improved knowledge of the welding characteristics of plate materials, advanced welding from an art to a science. Later the submerged-arc method appeared largely to eliminate the human equation and speed up production.

As the author points out, welding has been abused and accidents due to poor welding have occurred. These will be largely eliminated through our advanced knowledge of the welding characteristics of plate materials, the employment of procedure controls, adequate supervision, and inspection.

The welded locomotive boiler has arrived, and its arrival marks the end of the limitations on performance and design imposed by riveted joints. Carbon steel used in the present welded boilers will be followed by the higher-tensile alloy steels of 75,000 psi minimum tensile strength or even higher to save weight for operation at higher steam pressures, particularly for steam-turbine drives.

The elimination of cracked riveted seams, costly but, fortunately, involving relatively few boilers, is the immediate gain to be realized from welding. Welding the boiler seams will have no influence on the life of fireboxes, side sheets, tubes, flues or any other condition of maintenance or operation of the boiler except that pertaining to riveted shell joints.

Two Midwestern railroads have on order fifteen or sixteen welded boilers to replace boilers with cracked riveted seams. Both classes have a bad record of cracked side sheets. No change is contemplated in the side sheets of the new welded boilers; hence the bad record can be expected to continue in the new welded boilers.

Leakage of stay bolts has been proved to be the most prolific cause of cracked sheets from data on a series of tests started in June, 1942, and now embracing over sixty locomotives on eleven railroads. The proof is found in the complete elimination of side-sheet maintenance in all cases where leakage is avoided. The conventional method of hammering on the end of the stay bolt to expand it in the threads, then riveting-over the end, lacks permanence in maintaining tightness against leakage. Seal-welding or expanding by means of explosive charges provides greater permanence and hence longer side-sheet life.

The increased diameter of the threads on reduced-body or upset-end stay bolts is a further improvement by reducing the stresses on the threads materially.

The design of the stay-bolted firebox structure could well be improved in keeping with the advance made in the design of the boiler shell through welding.

The 7500-psi rule is rather strange, in that it forces the use of stay bolts of such size as to impose greater stresses on the stay and on the fastening than are obtained with smaller-diameter stay bolts stressed under boiler pressure at some higher value. For example, suppose that 1-in-diam straight-body stay bolts stressed to 7000 psi due to boiler pressure, which is obtained on a 4-in. × 4-in. spacing at 271 psi working pressure, were replaced with $^7/_8$-in-diam straight-body bolts, then the stress due to boiler pressure is increased to 9260 psi. However, for a given degree of bending, the total stress, i.e., the stress due to bending plus the stress due to boiler pressure, is actually lower, with the greatest benefit being obtained in the marked reduction in the stresses imposed on the fire sheet. Specifically, for a total displacement of 0.020 in. between the fire sheet and the wrapper sheet for stay bolts in an 8-in. water space, the bending stress imposed on the 1-in. stay bolt is calculated to be 24,400 psi and on the $^7/_8$-in. stay bolt 20,900 psi, making a total stress of 31,400 psi and 30,260 psi, respectively. The resistance to bending which is translated into tensile and buckling stresses in the firebox sheet is reduced from 868 lb per bolt for the 1-in-diam stay bolt to 464 lb for the $^7/_8$-in., or $46^1/_2$ per cent.

Perhaps the original meaning of the 7500-psi rule can be retained to apply only to the threaded portion of the stay bolt. By reducing the portion of the stay bolt between the sheets to a smaller diameter, say, such that the stress due to boiler pressures does not exceed 9500 or 10,000 psi, the efficiency of the assembly will be markedly increased.

Relief in this direction has been extended by the A.S.M.E. Boiler Code Committee for staying locomotive-type boilers in stationary service by allowing a stress limit of 9500 psi for nickel-copper (Monel) stay bolts.

The advent of the welded boiler is most welcome and it is hoped that other improvements will follow soon to reduce materially the inordinately high maintenance and operating expense of the conventional locomotive boiler.

COMMENT BY RALPH P. JOHNSON[5]

The author has ably presented the background and history of this interesting subject and outlined the attractive features of welded boilers to the railroad industry. The writer would like to suggest a thought that might expedite their use.

The author has described the difficult task of drawing up a satisfactory welding code for the A.S.M.E. Committee. In safeguarding a new process it is possible that precautions were included that definitely hindered the adoption of this rapidly improving technique, for example, stress-relieving. This is a practice universally approved for higher-carbon steels but of doubtful value with such low-carbon steels as boiler plate. Originally, welding stresses were relieved by "peening" and foreign experimenters proved, at

[4] Development and Research Division, The International Nickel Company, Inc., New York, N. Y. Mem. A.S.M.E.

[5] Chief Engineer, Baldwin Locomotive Works, Philadelphia, Pa. Mem. A.S.M.E.

least to their own satisfaction, that the same result was obtained by the building-up and releasing of pressures within a welded structure. If such methods could be proved and substituted for the present requirement of stress-relieving, it would go a long way toward popularizing welded boilers. A furnace of sufficient size to stress-relieve a modern locomotive boiler with accurate temperature control costs around $100,000 and can turn out only one boiler in 24 hours. Naturally, this cost will have to be assumed by the customers, and they are already complaining of the increased cost of steam locomotives. The writer submits that many precautions put into so-called "Codes" are placed there in an excess of caution and once in a code are practically impossible of elimination.

Likewise, excessive caution on the part of the I.C.C. prevents boiler builders from equipping themselves with the expensive devices necessary to do this type of work. All marine boilers are welded and lives on shipboard are in greater jeopardy from a boiler explosion than on a railroad. A welded locomotive boiler has been in satisfactory service for 7 years. Several more have been authorized. Must the industry wait 10 years more before freely using a technique that has already been adequately proved.

COMMENT BY H. B. OATLEY[6]

All will agree that this paper very well sets forth the case for the welded-type boiler. The discussion has also brought out clearly that the experience with the D.&H. boiler[7] has been all that could have been expected and that the more than 6 years' test period has been successfully carried out. Presentation of the position of the I.C.C. Bureau of Locomotive Inspection is evidence of full co-operation of the Bureau in the provisions of the law under which it acts to provide safety to all reasonable degrees.

There is every indication that safe and satisfactory service can be expected from welded boilers constructed under the requirements which were fully met in the D.&H. boiler.

It would appear that the provisions of the A.S.M.E. Boiler Construction Code give assurance that when these provisions are met, acceptable construction can be expected. This construction code, like several others, is a safety code. There must be in it all of the requirements for reasonably safe construction. It is not a finished document in the sense that revisions cannot be made. Development of new materials and methods of construction, when proved to be suitable and capable of being used with safety, become part of the revisions that are annually made in the code. It is a means of encouraging the thorough testing of new methods of construction and new materials and demonstrating that safety will not be lowered if provision for such use is provided in the code.

From the paper and the discussions the writer is impressed with the fact that the railroads are confronted with no obstacles in the use of the welded-type boiler. Locomotive builders are assuredly in a position to produce, in full accordance with good practice, boilers of this type and the I.C.C. Bureau of Locomotive Inspection may assuredly be expected to co-operate in all reasonable ways in making available the acknowledged advantages of welded boiler construction.

COMMENT BY A. F. STIGLMEIER[8]

The writer can speak only as a practical boilermaker; not as an engineer. It may be assumed further that the writer's only interest is to see the steam locomotive continue to advance, and to make certain that boilers are built in the best way possible so they may stay in service with a minimum of maintenance.

Some years ago the railroads demanded from the builders locomotives of greater capacity with less weight, equipped with boilers accommodating higher steam pressures. At that point nickel-steel boiler plate was adopted. The results obtained are quite well known; plates checked out at rivet holes after a short time in service. Many experts stated that cracked sheets were caused by caustic embrittlement. While this may have been one of the contributing causes it must not be overlooked that little was known by the locomotive builder of the proper procedure to be followed in the fabrication of nickel steel. In the writer's opinion, the boilermakers had much to do with the cracking of these alloy-steel plates at rivet holes, both in the circumferential and longitudinal seams. The cause was poor fit of the shell courses and excess tonnage used in driving rivets.

While the writer is in full agreement with the author's belief that the all-welded locomotive boiler is on its way, and will no doubt be the boiler of the future, there is need to give immediate study to methods of fabricating and welding alloy steel. As stated in the paper, a saving of 3000 to 6000 lb can be made by adoption of the all-welded boiler. It is assumed that this saving will result from eliminating weld straps and rivets. This saving we must question, for the reason that the all-welded boilers built to date and those contemplated utilize carbon-steel plate rather than alloy steel. In riveted boilers previously built of alloy-steel plate, $^{7}/_{8}$-in-thick plate was used which, if built with carbon steel, would have required a thickness of $1^{5}/_{32}$ in.

This plate requirement we are given to understand is because of not knowing the proper procedure to follow in welding alloy-steel plates in locomotive boilers. It is sincerely hoped that we will not again proceed with the use of alloy-steel plates and make the same mistakes that were made in the case of riveted construction.

The writer would suggest that a committee be appointed to give immediate study to the formulation of a procedure for the welding of alloy-steel plates for locomotive boilers, there being no question but that to continue the steam locomotive as an economic prime mover we must have boilers capable of carrying higher steam pressures, and boilers 3000 to 6000 lb less in weight than the boilers being built today of carbon-steel plates.

AUTHOR'S CLOSURE

The author is greatly pleased that this paper has produced such a widespread indication of interest in welded locomotive boilers. The comments offered cover a somewhat different analysis by each man and furnish a coverage of broad proportions.

Mr. Adair asks for general acceptance of welded bracing before the Bureau of Locomotive Inspection can agree to this extension of welding for locomotive boilers.

Mr. Huston points out that improved stay-bolt proportions and application will lengthen the life of the firebox.

Mr. Johnson suggests the omission of stress-relieving when the boiler plate is plain carbon steel.

Many welded structures cannot be stress-relieved but it is a practice that must be retained for the strength welds of locomotive boilers.

Mr. Oatley gives assurance that the A.S.M.E. Boiler Construction Code rules will not be static but will as heretofore keep pace with progress in the welding art.

Mr. Stiglmeier gives the viewpoint of the practical boilermaker and points out the advantage of using alloy steels for additional saving in weight.

JAMES PARTINGTON.[9]

---

[6] Vice-President, The Superheater Company, New York, N. Y. Mem. A.S.M.E.

[7] "Fusion-Welded Boiler on D.&H. Locomotive," by G. S. Edmonds, MECHANICAL ENGINEERING, vol. 68, 1946, pp. 619–621.

[8] General Supervisor of Boilers and Welding, New York Central System, New York, N. Y.

[9] Manager, Engineering Department, American Locomotive Company, New York, N. Y. Mem. A.S.M.E.

Welded Locomotive Boiler

COMMENT BY J. G. ADAIR[10]

The paper[11] presents an excellent and thorough account of the performance and durability of the D.&H. welded locomotive boiler. However, it is not made clear whether the author intended to ascribe the comparative freedom from the necessity of firebox repairs to the presence of the welded boiler shell. The throat-sheet repair mentioned refers to the inside throat sheet and not to the shell throat sheet. It is not apparent that the character of joints in the shell, either riveted or welded, would have any effect on the life of the firebox sheets.

The riveted boiler shells to which the repairs described by the author were made were built in the first world war year, 1918, for 20 class 1200 or E6A locomotives. These boilers are of two-course construction and are of substantially the same dimensions as the welded boiler which displaced one of the riveted boilers.

All these riveted boilers developed defects (other than the need of calking of which there is no record) at or in the vicinity of the riveted dome connections, but in the approximately 28 years' service to date, similar to that in which the welded boiler has been used, no defects have developed in or in the vicinity of any of the other riveted shell joints. The minimum age at which repairs were first applied to the riveted joints of the shells of any of these boilers was 9 years and 11 months; the maximum age at which such repairs were first applied was 17 years and 3 months.

The first boiler for an E6 locomotive was built in 1916, two years prior to those for the E6A locomotives; these boilers were substantially alike in all respects. The first-mentioned boiler has been in use over a period of 30 years and no defects have as yet developed in any of the original dome or shell joints.

The necessity for repairs to the E6A boilers has been generally ascribed to the presence of riveted joints, but the performance of the E6 boiler over a period of practically a third of a century and the many other riveted boilers of equal or greater age, without the necessity of repairs to or in the vicinity of the original riveted joints, furnishes food for thought that the failures in the E6A boilers may not be wholly due to the riveted construction. Table 1 of this comment gives the maintenance record of these locomotives.

TABLE 1 D.&H. LOCOMOTIVES NUMBERS 1200 TO 1220—CLASS E6A AND E6[a]

Locomotive class and number:	Riveted or welded boiler	Working steam pressure psi	Weight—On driving wheels, lb	Weight—Total engine, lb	Starting tractive effort, lb	Factor of adhesion	Repairs to original joints in boiler shell	Age of boiler as of March, 1946
Class E6A, 1201–18, 1220	Riveted	215	268900	297500	68800	3.90	All these boilers repaired[b]	27 years 7 months
Class E6A 1219	Welded	225	269800	301200	72000	3.75	None	8 years 6 months
Class E6 1200	Riveted	215	271200	295100	68800	3.96	None	30 years

[a] All boilers of substantially the same dimensions.
[b] All repairs to original joints consisted of repairs at dome connections. No other original joints involved. First repairs applied at various ages from 9 years 11 months to 17 years 3 months.

A slight saving in weight was accomplished in the welded boiler over the riveted boiler that it replaced but the total engine weight was increased somewhat, apparently due to increase in strength of some parts of the running gear. The welded boiler carries higher working steam pressure than the riveted boilers which results in reduction of the factor of adhesion to a point where, in some services, the locomotive might be regarded as too prone to spin the driving wheels.

[10] Mechanical Engineer, Bureau of Locomotive Inspection, Interstate Commerce Commission, Washington, D. C. Mem. A.S.M.E.

[11] "Fusion-Welded Boiler on D.&H. Locomotive," by G. S. Edmonds, MECHANICAL ENGINEERING, vol. 68, 1946, pp. 619–621.

The Technical Man's Cause Is Not Hopeless

TO THE EDITOR:

I was much interested in Bill Maddock's recent letter[12] on the technical man's plight. At first glance, I thought that the writer had "gone communistic," but after reading the letter a second time, I feel that he was not using this publication as a sounding board for Communism but was rather "sounding off," as we all have at one time or another.

When I was graduated as an M.E. (more years ago than I like to admit) and went to work for Bethlehem Steel, I started at an hourly rate that paid me $17.08 for a 60-hr week. At that time skilled workers in the plant were paid 80 cents per hr on day work, and they made a lot more on piecework. So-o-o, I had "wasted four years in getting an education," and I felt that way for a while.

But then after a short time I was taken off an hourly paid job, given a little bit of responsibility and some more money; and I began to realize that my salary carried with it paid vacations and a lot more security than any hourly paid job. When work was scarce the "bricklayers" (per Mr. Maddock) were laid off.

I've worked as a salaried engineer for two or three big companies and I've seen a lot of the hourly workers, who made two or three times as much as I did to start, come and go; and I still think that spending four years in a technical school was a good investment.

To me Mr. Maddock (and I notice he's a Junior member) is a victim of the "impatience of youth." He, and I've worked and sympathized with a lot of engineers like him, is disappointed when he doesn't make a VP's salary in three or four years. But I doubt that shaking the bonds of professionalism is the answer.

When a young engineer is graduated, he feels that his degree makes him worth more than any skilled mechanic. He overlooks two facts: (1) The mechanic has probably served a lengthy apprenticeship of training period at very low pay and (2) the young engineer without business training is, frankly not very valuable, except potentially, to any concern.

We all know that supply and demand determine wage and salary scales as they do the price of eggs. However, from time to time, I have been privileged to sit in on the councils of top management and I know that a sincere desire exists to provide technical men with good salaries and good working conditions in general. It is only prudent business judgment to protect management's investment of thousands of dollars spent to train a young engineer.

K. B. KEEFER.[13]

[12] "The Technical Man—Capital's Last Line of Defense," MECHANICAL ENGINEERING, vol. 68, 1946, p. 660.

[13] Chicago, Ill. Mem. A.S.M.E.

REVIEWS OF BOOKS

And Notes on Books Received in the Engineering Societies Library

Industrial Shangri-la?

THE PERSONNEL PROGRAM OF JACK & HEINTZ. By Roswell Ward. Harper & Brothers, New York, N. Y., 1946. Cloth, 5 × 7¼ in., 146 pp., illus., $2.

LINCOLN'S INCENTIVE SYSTEM. By James F. Lincoln. McGraw-Hill Book Co., Inc., New York, N. Y., 1946. Cloth, 5¾ × 9 in., 192 pp., illus., charts, $2.

REVIEWED BY J. M. JURAN[1]

ONE dream of the enlightened champions of free enterprise is a land of high production, low costs, high wages, and high profits. That all these ingredients can live happily together is misunderstood, doubted, and even denied by many industrialists, labor leaders, and government officials. Only through convincing demonstrations in actual operations can there arise a broad belief that these conditions are not mutually exclusive. The books under review purport to present an analysis of "how it was done" in the two most conspicuous examples of such actual operation, Jack and Heintz, Inc., and the Lincoln Electric Company, both of Cleveland, Ohio.

A word about the two companies is in order. Jack and Heintz, organized in 1940, flourished as a "war baby," making aircraft components and other war products. Generally, the work was intricate and precise rather than hack work by the ton. The automatic pilot and the aircraft starter were among the important products. Lincoln Electric has a much longer history, going back for decades. Originally a vigorous small company, competing with giants in making welding machinery and welding rod, it has for years outdistanced competitors in production, costs, wages, and profits. A similar record, during the war, is claimed for Jack and Heintz. Of all this, more later.

The first of the books "The Personnel Program of Jack and Heintz" is by Roswell Ward, a professional writer. It is to Mr. Ward's credit that his analysis has penetrated beyond the wolf calls, dental services, ultraviolet rays, and other outward evidences of a far-reaching personnel philosophy practiced by the proprietors. With rare exceptions, journalists visiting the Jack and Heintz plant had returned to make big news of the outward evidences. They and their readers remained blissfully ignorant of the more obscure but far more important fact that there was operating, in the plant, an exciting personnel philosophy, with broad industrial implications. If indeed there existed in this war plant the means for higher production, lower costs, higher wages, and higher profits, then there arose the challenge—how much of all this could be made to operate under peacetime conditions. Clearly, if the program could be converted to operate as well in peacetime, the proprietors had in their possession a new formula for economic success, and thus, the basis for founding a new industrial empire.

But while Mr. Ward has indeed penetrated the outward shrubbery, he appears to have spent himself in the process. His analysis of the real phenomenon, the personnel philosophy, is hardly sufficiently realistic or complete to constitute a conclusive demonstration.

The reader will find that the program is no more than a collection of very familiar ideas. The difference, so well emphasized by Mr. Ward, is that in Jack and Heintz, the managers really meant it. They were honest in their determination to correct grievances, to establish economic security, to develop physical security, and to do all those things implied in the term "associates" they adopted in lieu of the term "employees."

Mr. Ward makes out a good case for the value of this honest determination per se. As to whether it is this honest determination to treat employees as associates which has brought about an Industrial Shangri-la, his case is entirely unconvincing, both in the matter of whether a Shangri-la has indeed been attained, and whether it is the personnel program which attained it.

As to the economic achievement, little is said of the fact that Jack and Heintz was a wartime phenomenon. In the minds of many the question may be formulated: "Can all this happen in a peacetime competitive economy? It is perhaps easy to maneuver dashingly when one has a six-inch-pipe connection to the U. S. Treasury. But what of the time when there is no absolute guarantee of orders and credit?" It would have been of great value had Mr. Ward examined incisively this important question. Instead, his examination is superficial, consisting essentially of quotations from statements made by company officials. On the much publicized cost performance on the automatic pilots, the story cannot be considered as fully told until there is a comparison of the elements of cost of Jack and Heintz with, for example, those of the Sperry Gyroscope Company.

Of equal significance is the question "Is the personnel program the sole reason for these achievements?" Mr. Ward blandly assumes that it is. Perhaps he is right, but such an assumption is quite a leap in the dark. Again, an economic analysis would be in order. But more than this, an analysis of the minds of the associates would be in order.

Here is perhaps the main weakness of Mr. Ward's book. He has seen the outward evidences of the program and has talked to the proprietors. However, he has not recorded the feelings of the associates themselves. If the program did in fact develop in them a new sense of participation and all that flows therefrom, the book is devoid of any direct testimony.

The second book "Lincoln's Incentive System" is by James F. Lincoln, the proprietor himself. Those who have heard Mr. Lincoln on the lecture platform would be led to suppose that so alert a mind would produce a crystal-clear book on this subject. They will be disappointed.

On the story of economic achievement the author is clear enough. His analysis of relative costs and of the elements of cost carry conviction. Nor is the issue befogged by the possibility of mysterious goings-on under war contracts, for Lincoln Electric did these things long before World War II. The case for the simultaneous presence of high production, low costs, high wages, and high profits is well established.

The clarity vanishes when Mr. Lincoln undertakes to explain how he did it. Evidently Mr. Lincoln has much on his mind; New Dealers, bureaucrats, taxes, unions, and related phenomena. His

[1] Professor and Chairman, Dept. of Administrative Engineering, New York University, New York, N. Y. Mem. A.S.M.E.

views on these institutions are stated forcibly, and are strewn in profusion throughout the book. The connection between these views and "Lincoln's Incentive System" is seldom obvious.

As one goes through the book, peering through the political fog banks, it develops that Lincoln's Incentive System is a collection of familiar and well-known devices; piecework, promotion from within, profitsharing, and others. This is so much the case that many managers might be tempted to exclaim "Why, I do all of these things!"

However, the book discloses, and this time with three-dimensional clarity, the presence, in this Company, of Mr. Lincoln's fierce sense of fair play, his intense sincerity, and his unqualified determination to make the workman a member of the team. Few, very few, managers can claim to possess these assets to so full an extent.

Is Lincoln's Incentive System then merely the wholehearted carrying out of these well-known ideas? If there is any other explanation, it has escaped this reviewer. The author himself senses this to be the explanation. Like Ward, he has failed to measure the mind of the workman. Unlike Ward, he bemoans the shortcomings of industrialists, so much so that he calls for a new industrial leadership. Here, however, he is in deep waters.

Mr. Lincoln's broader social and economic thinking is to the effect that this is the age of industry, and that therefore the leaders should come from industry. If one accepts this line of argument, he must, however, be mindful that the workmen in industry, under the democratic rule of government by consent of the governed, must perforce have something to say about choice of the leadership.

Perhaps the crux of the whole matter lies in the question: "Is Lincoln's Incentive System one which can be operated by managers possessed of ordinary human failings, or does the system require managers born of a new breed of human beings?" As we look over the list of characteristics demanded by the author, of the "new leadership", we can well remain gloomy. A new "system" predicated on the absence of frailties in human nature is a system in theory only. It is successful in its application only in that minority of instances where, by a fortuitous set of circumstances, the variables all lie in the same direction.

Yet, Lincoln Electric Company's achievements are so far beyond the norm that Lincoln's methods cannot be dismissed lightly. Could we, by careful selection and intense training, generate enough managers to do the job in the manner done by Mr. Lincoln? Possibly so. But we would first have to rewrite the specifications. Mr. Lincoln's effort, written while his eyes were still blinded with the honest gore of his battle with the bureaucrats, necessarily falls short of the mark.

The fact that two authors have drawn even incomplete charts is of course helpful. Whether the pioneer voyage to an Industrial Shangri-la is analyzed by the manager or by someone else, the principles of navigation will very likely be identical. But, in Jack and Heintz, or in Lincoln Electric, or in unnamed instances, the route of the exploration is yet to be clearly traced.

Women Can Be Engineers

WOMEN CAN BE ENGINEERS. By Alice C. Goff, Youngstown, Ohio. Privately published by the author, 1946. Cloth, $5^1/_2 \times 8^1/_2$ in., 238 pp., $2.50.

REVIEWED BY LILLIAN M. GILBRETH[2]

THIS short book of 227 lithoprinted pages fills a real need. The author, herself an engineer, has carefully collected and presented material on the lives and work of nineteen women in or related to the various branches of the engineering profession.

Every engineer is asked to advise girls or women who are interested in what engineers do, and the chances women have to train for and then work at engineering jobs. There have been articles on opportunities for women in engineering in various "career" books, but this book tells not only what the jobs require but gives interesting accounts of women actually doing them.

This is a book to be used for vocational guidance. It is also a book to be consulted if one is asked "can women be engineers?". It shows they can be, and tells how and why.

[2] President, Gilbreth, Inc., Montclair, N. J. Fellow, A.S.M.E.

Library Services

ENGINEERING Societies Library books may be borrowed by mail by A.S.M.E. members for a small handling charge. The Library also prepares bibliographies, maintains search and photostat services, and can provide microfilm copies of any item in its collection. Address inquiries to Ralph H. Phelps, Director, Engineering Societies Library, 29 West 39th St., New York 18, N. Y.

Books Received in Library

LIVING BIOGRAPHIES OF GREAT SCIENTISTS. (Blue Ribbon Books.) By H. Thomas and D. L. Thomas. Doubleday, Doran & Co., Inc., (Garden City Publishing Co.), Garden City, New York, N. Y., 1946. Cloth, $5^1/_2 \times 8^1/_4$ in., 314 pp., illus., $1. Brief anecdotal biographies of twenty-one eminent scientists from Euclid to Einstein are presented in this book. A wide range of the fields of science is covered: astronomy, mathematics, biology, physics, medicine, chemistry. This is one of a series of twelve volumes presenting biographies of famous people from all categories of human endeavor: composers, painters, statesmen, and rulers.

MACHINE OPERATION TIMES FOR ESTIMATORS, Standard Data and Methods. By J. C. Derse. Ronald Press Company, New York, N. Y., 1946. Cloth, $6 \times 9^1/_2$ in., 156 pp., illus., diagrams, charts, tables, $6. This book presents data and methods specifically designed to meet the estimator's needs for the different kinds of work done on the machines commonly found in metalworking plants. The standard elemental manual and machine-operation times have been established by experienced checking over a considerable period, and methods are given for adapting the data to individual shop conditions. Case examples for numerous typical jobs are worked out in full detail. The book is intended not only for estimators but also for time-study men, production managers, and others concerned with job times and procedures.

MACHINING OF STEEL, Simply Explained. By F. C. Lea and E. N. Simons, Blackie & Sons, Ltd., Glasgow, Scotland, and London, England, 1945. Cloth, $5 \times 7^1/_2$ in., 214 pp., illus., diagrams, 8s 6d. Written for both the practicing machinist and the student, this small manual first describes the major types of metal-cutting machines with notes on their uses and efficient operation. Part 2 covers the principles of steel cutting: speeds and feeds, coolants, jigs, gages, and very briefly, heat-treatment. Part 3 discusses the tools involved in these cutting operations with notes on maintenance and correct handling. There is a separate chapter on plain and compound indexing.

MATERIALS-HANDLING EQUIPMENT, a Modern Manual. By M. W. Potts. Pitman Publishing Corporation, New York, N. Y., and Chicago, Ill., 1946. Cloth, $5^1/_2 \times 8^1/_4$ in., 172 pp., illus., $2.50. This book is devoted to defining, describing, and presenting the application of a number of standard types of materials-handling equipment. Earth-moving and other equipment used primarily by contractors, and specialized units for certain industries have been omitted. Types covered are dealt with under the following section headings: conveyers, elevators, hand-operated equipment, hoisting machinery, trackless carriers, tractors and trailers, and miscellaneous equipment with general applications.

MECHANICAL WORLD YEAR BOOK 1946. Emmott & Company, Ltd., London, England. Fabricoid, $4 \times 6^3/_4$ in., 360 pp., diagrams, charts, tables, 2s, 6d. This year book provides

a pocket-size manual of information on machine-shop practices, light alloys, plastics, bearings, steam boilers, turbines, internal-combustion engines, welding, and other topics of interest to manufacturers and mechanical engineers. There is a large amount of tabular matter presenting useful mathematical and engineering data.

TENSEURS EN MÉCANIQUE ET EN ELASTICITÉ. By L. Brillouin. Dover Publications, New York, N. Y., 1946. Cloth, 6 × 9½ in., 364 pp., illus., diagrams, charts, tables, $3.75. This book presents an exposition of tensor analysis and its applications in theoretical physics. The range of the book is indicated by the chapter headings: vector geometry; pseudo-tensors; the principal differential operators; parallelism, covariant and contravariant derivative; Riemann space; use of Riemannian geometries in analytical mechanics; transition of wave mechanics; elasticity and waves in elastic solids; theory of solids and quantum mechanics. There is an index.

WATER TREATMENT AND PURIFICATION. By W. J. Ryan. Second edition. McGraw-Hill Book Co., Inc., New York, N. Y., and London, England, 1946. Cloth, 5½ × 8¼ in., 270 pp., illus, diagrams, charts, maps, tables, $2.75. The purpose of this book is to make available to students, engineers, and plant managers a description, under one cover, of the several purification and other processes that are applied to water. The construction and operation of the different types of filtering, softening, and treating apparatus are described.

A.S.M.E. BOILER CODE

Interpretations

THE Boiler Code Committee meets monthly for the purpose of considering communications relative to the Boiler Code. Anyone desiring information on the application of the Code may communicate with the Committee Secretary, 29 West 39th St., New York 18, N. Y.

The procedure of the Committee in handling the cases is as follows: All inquiries must be in written form before they are accepted for consideration. Copies are then sent by the Secretary of the Committee to all members of the Committee. The interpretation, in the form of a reply, is then prepared by the Committee and is passed upon at a regular meeting.

This interpretation is later submitted to the Council of The American Society of Mechanical Engineers for approval after which it is issued to the inquirer and published in MECHANICAL ENGINEERING.

Following is a record of the interpretations of this Committee formulated at the meeting of September 13, 1946, and approved by the Council on October 24, 1946.

ANNULLED CASES

Cases Nos.	Based on Revision of Pars.
808	H-24
830	P-186(c)
901	P-2(e) and U-13(k)
923	P-299(a)
963	U-36(a)
972	Q-101(b)
1011	L-116
1014	P-186(c)
1018	Tables P-5, P-7, U-2
1019	P-108(a) and U-76(b)
1024	U-75

CASE NO. 1021 (Reopened)

(Special Ruling)

Inquiry: There is considerable evidence that the addition of 0.5 per cent chromium to carbon-molybdenum steel, plus a limitation of the aluminum addition for deoxidation, plus a limitation on austenitic grain size will inhibit graphitization of the material under conditions of high-temperature service. Some of the factors involved are not definitely known and considerable work is being done in investigating the causes for graphitization and the most practicable means for preventing it. A new specification for seamless chromium-molybdenum steel pipe for service at high temperatures has been developed by the American Society for Testing Materials, and has been approved for use under the Code as Specification SA-280. There is need for a corresponding chromium-molybdenum type of plate, casting, and forging material for new and existing boiler installations operating at temperatures over 900 F. Will the intent of the Code be met if a new grade were added to the following Specifications to include a chromium content of 0.40 to 0.70 per cent: SA-204, plates; SA-217, Grades WC1 and WC2, castings; SA-182, Grade F1, forgings? The application would be to Par. P-103 and to Table Q-5. There would be no change in the allowable stress as given in Tables P-5 and P-7 from that for carbon-molybdenum without the chromium.

Reply: Pending revision of existing specifications to include the chromium addition, it is the opinion of the Committee that the proposed chromium addition to carbon-molybdenum specifications will meet the intent of the Code. When welded, constructions built of these materials shall be thermally stress-relieved for all thicknesses.

CASE NO. 1031

(Interpretation of Pars. P-286 and P-289)

Inquiry: Pars. P-286 and P-289 specify that certain safety-valve inlets be flanged and it is assumed that the intent was to prohibit the use of screwed connections. In the higher pressure and temperature boilers it is desirable to eliminate gasketed joints. Is it permissible under the Code to attach safety-valve inlets to boiler drums or superheater headers by welding, provided the welding is done in accordance with Code requirements?

Reply: It is the opinion of the Committee that the use of welding to attach safety valve inlets to boiler drums or superheater headers will meet the intent of the Code provided the welding is done in accordance with Code requirements.

CASE NO. 1032

(Interpretation of Par. P-186b)

Inquiry: Is it permissible, under Par. P-186(b), to double butt-weld the longitudinal seam in a wrapper sheet when the seam is in the flat plate between two rows of staybolts and the welding procedure and operators are qualified under Section IX of the Code?

Reply: It is the opinion of the Committee that the construction as outlined will meet the intent of the Code under Par. P-186(b), provided the waterleg does not exceed 4 in. in width.

CASE NO. 1033

(Interpretation of Pars. P-3 and U-13)

Inquiry: To clarify an omission may material made by the electric-furnace method be used in Code constructions?

Reply: It is the opinion of the Committee that any material made by the electric-furnace method which is approved in any Code specification will meet the intent of the Code.

CASE NO. 1034

(Interpretation of Tables P-5, P-7, U-2, and U-4)

Inquiry: Tables P-5, P-7, U-2, and U-4 of the Code give maximum allowable working stresses for electric-resistance-welded alloy steel tubes conforming with Specification SA-249. What allowable working stresses are permitted for atomic-hydrogen-welded steel tubes to the same specification?

Reply: It is the opinion of the Committee that it is permissible to use the same allowable working stresses for atomic-hydrogen-welded tubes conforming with Specification SA-249 as given in Tables P-5, P-7, U-2, and U-4 for electric-resistance-welded alloy steel tubes of the same specification.

A.S.M.E. NEWS

And Notes on Other Engineering Societies

A.S.M.E. Petroleum Committee Re-establishes Society Activities in Petroleum Mechanical Engineering

National Conference Attracts 300 Engineers

WITH the success of the 1946 National Conference on Petroleum Mechanical Engineering held at the Mayo Hotel, Tulsa, Okla., Oct 7 to 9, 1946, the Petroleum Committee of the Process Industries Division of The American Society of Mechanical Engineers not only re-established A.S.M.E. service to mechanical engineers in the petroleum industry, but also demonstrated its ability to carry on the program of the old A.S.M.E. Petroleum Division which was dissolved in 1943.

Three hundred engineers registered at the Conference but many more participated in the three-day program composed of 18 sessions at which 37 papers were presented on mechanical problems in the following divisions of the petroleum industry: production, engineering, refining, transportation, materials of construction, application of petroleum and its products, and the manufacture of petroleum equipment.

Out of the Conference will come a printed volume containing all papers and written discussion pertaining to each paper. The volumes will be distributed to all who registered at the Conference and to others who write for copies. (See box on page 1090.)

The 1946 National conference was the first national event sponsored by the Petroleum Committee and marked the culmination of the efforts of a handful of A.S.M.E. members who organized to continue the important work begun by the old A.S.M.E. Petroleum Division. The committee recognized that while many phases of petroleum technology were being efficiently served by societies such as the American Petroleum Institute, many opportunities for research and development involving the mechanical phases of the industry were being overlooked. It is to these mechanical problems that the Committee addressed itself.

The large attendance at the 1946 National Conference not only encouraged the Petroleum Committee in its work but also created the opportunity of many members to become acquainted with its program of activities. Organized in 1943, the Committee has a current membership of 550 but this is expected to be considerably enlarged as a result of the enthusiasm created by the Conference.

President Yarnall Speaks

D. Robert Yarnall, president, A.S.M.E., officially opened the National Conference at a luncheon, Monday, Oct. 7, where he spoke to 500 engineers and guests on "Engineers and Human Affairs."

President Yarnall said that the most important problem facing the engineering profession today was the pressure by labor unions to organize engineers and especially young engineers, many of whom have a strong desire for collective action.

"If we were young engineers employed in a large company today," he said, "we would be pressed to join with a representative bargaining group because unions are doubling their efforts to organize engineers. From what I hear of the experience of young engineers, there seems little else that can be done in most circumstances."

The problem is serious, he continued, because engineers in the middle-age and older groups are very largely executives and managers and chief engineers who look upon the young engineers as the potential from which the next generation of managers and executives may come.

"If a young man joins a white-collar union representing engineers, how will the transition period from this classification as a union member and his classification as an executive or a manager be made?" President Yarnall asked.

As a possible solution to the problem, President Yarnall suggested that management must assume more responsibility for encouragement, recognition, and advancement of all technical men.

Public Luncheon

At noon, Tuesday, Oct. 8, a public luncheon was held in the Crystal Room, Mayo Hotel, to which engineers interested in the work of the A.S.M.E. Petroleum Committee were invited.

William Raisch, chairman, A.S.M.E. Petroleum Committee, spoke on "The Organization and Aims of the Petroleum Committee." He was followed by the six chairmen of the subcommittees of the Petroleum Committee who described the plans for the immediate future and invited engineers in the petroleum industry to participate in the program taking shape. As a result, personnel of all subcommittees were substantially increased.

The Banquet

The main social event of the Conference was the banquet held in the Crystal Room, Mayo Hotel, Tuesday, Oct. 8. Orval Lewis, chairman, A.S.M.E. Tulsa Arrangements Committee, presided. R. J. S. Pigott, fellow A.S.M.E., chief engineer, Gulf Research and Development Company, Pittsburgh, Pa., was toastmaster.

The Honorable E. H. Moore, United States senator from Oklahoma, was the guest speaker. His subject was, "Operation Under Free Enterprise Has Made Our Mechanical Development Superior to Any Other Country."

ONE OF THE MANY BRIGHT MOMENTS AT THE 1946 NATIONAL CONFERENCE ON PETROLEUM MECHANICAL ENGINEERING

(*Left to right:* Orval Lewis, chairman, A.S.M.E. Tulsa Arrangements Committee; W. Fred Stewart, chairman, A.S.M.E. Mid-Continent Section; C. E. Davies, secretary, A.S.M.E.; R. J. S. Pigott, fellow A.S.M.E., chief engineer, Gulf Research and Development Company; and Linn Helander, vice-president, A.S.M.E. Region VIII.)

SENATOR E. H. MOORE SPEAKING AT THE PETROLEUM COMMITTEE ANNUAL BANQUET

Senator Moore called for restoration of the Constitution as Thomas Jefferson and other great Americans had fathered it. He dwelt on the changes the New Deal had wrought and sought to perpetuate, and he criticized the different acts which had, through false promises and delusive arguments, developed a revolution against the American Constitution. "The hour for a revival of constitutional Americanism is surely at hand," he said.

Honored guests at the banquet were: The Honorable Lee Price, mayor of Tulsa; H. M. Cooley, president, Tulsa Engineers' Club; Linn Helander, vice-president, A.S.M.E. Region VIII; W. H. Carson, member A.S.M.E., dean, University of Oklahoma; R. L. Langenheim, dean, University of Tulsa; P. S. Donnell, dean, Oklahoma A.&M. College; G. P. Stocker, dean, University of Arkansas; H. F. Beardmore, chairman, Petroleum Division, A.I.M.E.; W. H. Strang, executive secretary, Petroleum Division, A.I.M.E.; C. E. Davies, secretary, A.S.M.E., and Ernest Hartford, executive assistant secretary, A.S.M.E.

Business Meetings

Business meetings of subcommittees were held during the Conference in order to formulate plans for the future and to recommend locations for the 1947 Conference. The majority seemed to favor having the next conference at Houston, Texas, during the early part of October. Suggestions for papers for presentation at the next conference were invited and as a result, a number of timely subjects were considered for places on the program.

A.I.M.E. Members Attend

In addition to the chairman and executive secretary of the Petroleum Division of the American Institute of Mining and Metallurgical Engineers, many other members of the A.I.M.E. participated in the Conference. The A.S.M.E. Petroleum Committee looks forward to continued co-operation between the two societies and the planning of joint meetings in the future.

Technical Sessions

Of the many sessions sponsored by the subcommittee on production petroleum engineering, one of the most interesting was the Drilling Session at which G. L. Kothny, member A.S.M.E., vice-president, Sperry-Sun Well Surveying Company, Philadelphia, Pa., presented a paper on "Controlled Directional Drilling." A spirited question and answer period followed Mr. Kothny's talk.

He reviewed the many tests that have been drilled directionally in California, Texas, Louisiana, and Oklahoma and declared that the greatest success in the program of slant-drilling was the discovery of many reservoirs of oil which otherwise would have remained irrecoverable.

A marked interest was shown in the production and refining practice sessions, which attracted large attendance. The transportation sessions were also popular.

As a service to members the Petroleum Committee is planning to publish papers with written discussions in a volume which will be available to all engineers interested in the Conference.

The following Committees were responsible for the success of the Conference:

Committees

A.S.M.E. Petroleum Executive Committee: William Raisch, chairman; E. W. Jacobson, secretary; G. L. Kothny, production engineering; C. L. Pope, product applications; E. W. Jacobson, transportation; Irving Taylor, refining; B. B. Morton, construction materials; J. M. Sexton, equipment manufacturers; and T. R. Olive, papers and publications.

A.S.M.E. Tulsa Arrangements Committee: Orval Lewis, chairman; D. E. Foster, vice-chairman; and C. A. Stevens, secretary.

Registration: Clarence Glasgow and John Keyes.

W. H. STUEVE, VICE-PRESIDENT, A.S.M.E. MID-CONTINENT SECTION (*left*) AND WILLIAM RAISCH, CHAIRMAN, PETROLEUM COMMITTEE OF THE PROCESS INDUSTRIES DIVISION (*right*) RELAX AT THE SMOKER

Petroleum Conference Papers

ALL papers and written discussion presented at the 1946 Conference on Petroleum Mechanical Engineering in Tulsa will be published in full in a single volume as soon as paper supply permits. The 35 papers to be included, which were detailed in the program appearing on pages 839–840 of the September issue of MECHANICAL ENGINEERING, cover a wide range of mechanical-engineering subjects of vital interest not only to the petroleum industry but also to equipment manufacturers and other engineers. Each registrant will receive one copy in consideration of his registration fee. Additional copies, as long as they last, will be available to everyone interested at a prepublication rate of $3, or a postpublication rate of $4.50. Prospective purchasers are urged to take advantage of the prepublication rate by mailing checks for as many copies as desired before Feb. 1, 1947, to Publication Sales Department, The American Society of Mechanical Engineers, 29 West 39th St., New York 18, N. Y.

Program and Hotels: D. A. Cant, chairman; F. J. Daasch, technical; Mrs. J. H. Keyes, social; W. E. Bauman, guest accommodations; and A. J. Hanssen, meeting accommodations.

Finance: D. E. Fields and L. W. Fagg.

Publicity: R. B. Tuttle and Jim Wilson.

Entertainment: R. G. Ayers and D. O. Johnson.

Plant Trips: L. T. Gibbs and R. A. Colgin.

A.S.M.E. Members Speak at I.A.S. Meeting

BRUCE E. DEL MAR, junior member A.S.M.E., mechanical test engineer, Douglas Aircraft Company, Inc., and Jerome E. Lederer, member A.S.M.E., chief engineer, Aero Insurance Underwriters, were among the authors who presented papers at the Fourth Annual Air Transport Meeting sponsored by the Institute of the Aeronautical Sciences.

The meeting was held in the U. S. Chamber of Commerce Auditorium, Washington, D. C., Oct. 24, 1946.

Mr. Del Mar spoke on "Air Conditioning of Transport Aircraft for Year Around Comfort in Flight and on the Ground." He analyzed the problems associated with providing adequate and constant air conditioning from the standpoint of design, rating, automatic control, and air-line operation of air-conditioning equipment.

Mr. Lederer, who spoke on "A Survey of Aircraft Rescue Requirements," commended the air-sea rescue organizations of the United States, Great Britain, and Canada for their coordinated work in the Atlantic. He stressed the need for a definite standard of performance for specific rescue requirements.

Successful Joint A.S.M.E.-A.I.M.E. Coal Meeting Held in Philadelphia, Pa.

Preparation, Utilization, and Sizes of Coal Discussed

NEARLY 325 members and guests of the two engineering societies attended the ninth joint meeting of the Coal Division of the A.I.M.E. and the Fuels Division of the A.S.M.E. held Oct. 24 and 25 in the Bellevue-Stratford Hotel, Philadelphia, Pa., with the co-operation of the Philadelphia Sections of both organizations and the Philadelphia Anthracite Section of the A.S.M.E.

The two-day program consisted of four technical sessions, two luncheons, a banquet, an afternoon tea party for the women, and an inspection trip. All the technical sessions were well attended and the papers, judging from the discussion, aroused much interest.

Coal Cleaning in The Netherlands

Coal cleaning was the topic of the opening technical session, Thursday morning, October 24, with two papers covering the hydraulic cyclone coal cleaner. M. G. Driessen, chief, mining research department, Staatsmijnen, Limberg, Netherlands, discussed the theory of flow in a cyclone under the assumption that it can be compared with an ideal sink in a non-viscous liquid. With the help of the Navier-Stokes equations in polar co-ordinates he demonstrated that a first approximation considering the effect of viscosity on the maximum tangential velocity near the cyclone core can be obtained.

For the velocities of small particles in media under the influence of gravitational or centrifugal forces he designed a new chart which gives the solution for a certain range of particle sizes and velocities, which cannot be calculated by an exact equation.

Dr. Driessen described the principle and behavior of cyclone thickeners and washers, in which he included flow sheets showing the position of the cyclones in heavy medium washeries.

He developed a method of "error" curves to judge the effect of separating apparatus for the cyclone thickeners separating small particles into coarser and finer fractions as well as for cyclone washers separating particles of various specific gravities into heavier and lighter fractions.

Dr. Driessen gave an example for the cyclone thickener, showing that the "separating size," where 50 per cent of a certain fraction is caught, is situated at a grain size of about 35 μ.

An example for the cyclone washer treating a middling product of 44.5 per cent ash shows that it is possible to wash particles down to 0.5 mm with a very high approximation to theoretical separation, whereas a washing effect down to 0.1 mm could be demonstrated.

In short, the use of hydraulic cyclones as thickness sand washers in modern coal preparation, as demonstrated by Dr. Driessen, results in coal cleaning that is appreciably faster than by present methods and effects possible savings that may be passed on to the consumer.

At this same session H. F. Yancey and M. P. Geer, U. S. Bureau of Mines, presented a paper giving a detailed description of the cyclone cleaner and a description of the preliminary tests designed to demonstrate the operating characteristics of the Dutch cyclone washer.

Cinders and Fly Ash

On Thursday afternoon R. C. Johnson, member A.S.M.E., vice-president, Anthracite Institute, Wilkes Barre, Pa., spoke on the combustion of anthracite in glass tubes. The talk was illustrated by a colored motion picture.

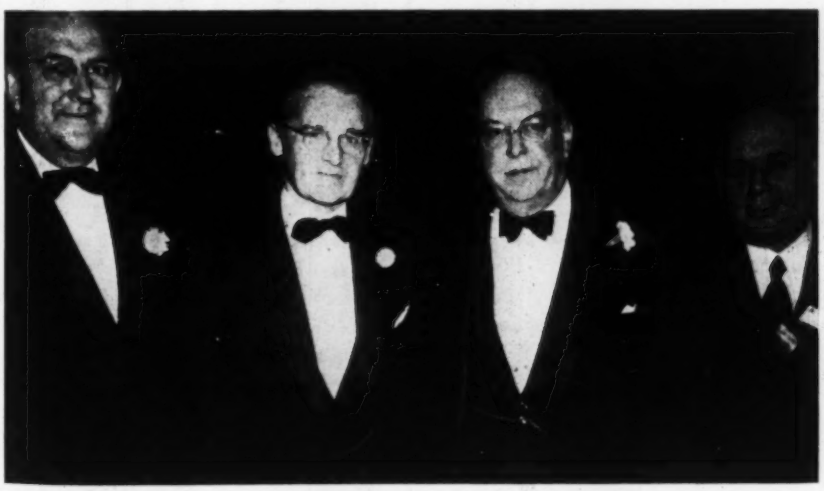
DR. ARNO FIELDNER (*right*) RECEIVES THE PERCY NICHOLLS AWARD FROM A. W. GAUGER (*left*) AT THE BANQUET

On the same program C. S. Gladden, member A.S.M.E., superintendent of power, Heyden Chemical Corporation, Morgantown Ordnance Works, Morgantown, W. Va., read a paper in which he presented: (*a*) Certain test data concerning the quantities and characteristics of cinders and fly ash which result when burning small sizes of anthracite coal on traveling-grate stokers; (*b*) the distribution of precipitation of cinders and fly ash at various collection locations in the path of the furnace gases from the boiler to the stack; (*c*) the influence of fines in the coal on the quantity of cinders and fly ash produced; (*d*) a description of an efficient method of recirculation of cinders and fly ash; and (*e*) economics to be expected by recirculating and reburning cinders and fly ash.

The grinding of anthracite for pulverized fuel was the subject of a third paper presented at this session. C. H. Frick, member A.S.M.E., plant-betterment engineer, Pennsylvania Power and Light Company, Allentown, Pa., was the author. Before presenting the main topic, his paper gave some of the high-spot history of the anthracite industry.

He then described the pulverizing equipment and boilers installed at the Hauto steam-electric station of the Pennsylvania Electric Company. The boilers are two of the largest in the world to burn pulverized anthracite. The preparation plant consists of two cylindrical rotating driers, each 600 ft long × 7 ft 6 in. in diameter and having a rated capacity of 30 tons per hr at normal speed, from initial moisture of 20 per cent (10 per cent ice and 10 per cent water) to a final moisture of 1 per cent; and three horizontal ball and tube mills, each with a ball charge of 37½ tons when grinding coal with a moisture content of 1 per cent to a fineness of 85 per cent through a 200-mesh screen.

Mr. Frick also described the Pine Grove and Lykens plants of the Pennsylvania Power and Light Company. The Lykens plant contained eight 42-in. screen-type vertical mills whereas the Pine Grove plant as designed contained three mills, each of 70 in. diameter, of the same type and make. After a few years' experience these were replaced by ball and tube mills.



PRINCIPALS AT THE JOINT A.S.M.E.-A.I.M.E. COAL MEETING IN PHILADELPHIA, PA.
(*Left to right.* J. E. Tobey, chairman, Fuels Division, A.S.M.E.; D. Robert Yarnall, president, A.S.M.E.; N. E. Funk, fellow A.S.M.E., chairman, general committee; and H. F. Hebley, chairman, A.I.M.E. Coal Division)

Modern Haulage

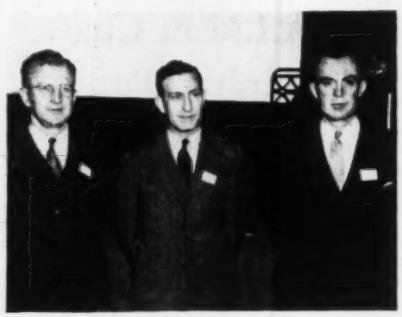
At the third technical session held Friday morning, October 25, G. Stuart Jenkins presented a paper entitled "Modern Haulage to Meet Local Conditions," in which he described the modern haulage system employed at the Consolidated Coal Company. He discussed the conditions involved in bituminous-coal-mine practices and the haulage of coal that is loaded with mobile loading machines in seams four feet or more deep.

Mr. Jenkins remarked that by utilizing a combination of shuttle cars, belts, and large pit cars, acreage that would otherwise be left intact could be extracted, and the saving resulting from the use of this combination of equipment more than offsets the increased capital investment with its accompanying increase in maintenance, depreciation, and obsolescence.

At the same session David R. Mitchell, J. H. Kelley, Richard L. Ash, J. D. Morgan, Jr., W. H. McCracken, and William Bellano jointly presented a paper on shuttle-car haulage. The paper, read by Mr. Mitchell, described rubber-tired shuttle cars used for shuttling back and forth between the loading machine and the section transportation system.

The essentials for shuttle-car operation such as the layout and operation of shuttle-car sections were discussed. Specifically covered by the paper were the accessory equipment needed, the mining conditions affecting the selection of shuttle-car type, and the shuttle-car design features of battery and cable-reel cars.

Also at this session D. E. Ingersoll read a paper written by G. A. Roos which described the Newkirk Colliery of the Philadelphia and Reading Coal Company The author pointed out that this is a modern anthracite mine developed entirely within the war period. The paper described the preliminary work, such as clearing the site, erecting temporary buildings, and providing other facilities for construction and development. Such tasks as driving the tunnel, ventilation during development, transportation and disposition of rock, the mining plan, permanent ventilation, power supply and distribution, and the outside plant were described in detail.



AT THE PANEL DISCUSSION ON THE SIZES OF COAL

(*Left to right*: E. C. Payde, the panel leader; Howard Herder; and Carl Mabley.)

Restriction of Number of Coal Sizes

The possibility of restricting the number of coal sizes to effect a saving for consumers was discussed at the fourth technical session held on Friday afternoon.

Nine engineers, representing all the coal-producing areas in the United States, joined in a discussion of how to reduce the large numbers of coal sizes and ways of standardizing size and names. There were said to be 70 sizes of bituminous coal alone.

D. C. Weeks, member A.S.M.E., presided at the discussion, and E. C. Payne, member A.S.M.E., was the panel leader. Individual papers were presented by Howard Herder (districts 9, 10, and 11) and Carl Mabley, member A.S.M.E. (district 8), representing the producers; for the combustion-equipment manufacturers, A. W. Thorson, member A.S.M.E. (large stokers) and G. L. Coryell (small stokers); consumers, A. A. Raymond, member A.S.M.E. (railroads), C. S. Sheaffer (retail and small industrials); research, Ralph A. Sherman, member A.S.M.E. (bituminous), and Paul A. Mulcey (anthracite). Mr. Payne hopes to correlate the various papers and draw conclusions from a screening of them.

Judge Corson and Don Rose Speak at Luncheons

The two luncheons held during the meeting were well attended and entertaining. At the luncheon Thursday the speaker was Judge George C. Corson of Montgomery County, Pa. Sidney T. Mackenzie, chairman, Philadelphia Section, A.S.M.E., was the toastmaster.

At Friday's luncheon, Don Rose, "Stuff and Nonsense" columnist, *Philadelphia Evening Bulletin*, was the speaker. The toastmaster was H. W. Montz, chairman, Anthracite Section, A.I.M.E.

Percy Nicholls Award Presented to A.C. Fieldner

Nearly 300 attended the banquet Thursday evening, the main social event of the meeting. A. E. Southgate, treasurer, Philadelphia and Reading Coal and Iron Company, was the toastmaster. He introduced A. W. Gauger, director of mineral industries, Experiment Station, Pennsylvania State College, who presented the Percy Nicholls Award to Dr. Arno Fieldner, U. S. Bureau of Mines, Washington, D. C. This award was established in 1942 and is awarded for notable scientific or industrial achievement in the field of solid fuels.

The speaker on the evening's program was C. F. Wagner, manager, Central Station Section, Industry Engineering Department, Westinghouse Electric Corporation, who gave a talk on the "Nuclear Power Plant." It was illustrated by slides.

Southwark Station Visited

On Friday afternoon a group visited the new Southwark Generating Station of the Philadelphia Electric Company, now in the process of being constructed. The Southwark site is capable of accommodating four cross-compound units of 150,000 kw rated capacity each, together with all necessary outdoor substation equipment.

The Babcock & Wilcox open-pass boiler units which will deliver steam at 850 psig and 900 F at the turbine throttle, will be of 850,000 lb per hr normal capacity each, capable, however, of producing 935,000 lb per hr for a 4-hour period. The boiler economizer is of the continuous-tube type. Two Ljungström regenerative-type air preheaters per boiler will be used, each preheater having 61,500 sq ft of heat-transfer surface.

The visitors saw the main cross-compound, Westinghouse, reaction, hydrogen-cooled turbogenerators, nominally rated at 150,000 kw each, 0.8 power factor, 13,800 volts. At this output, approximately 65,000 kw will be generated on the 3600 rpm, 19-stage, high-pressure unit, and 85,000 kw on the 1800-rpm low-pressure machine. The latter turbine is double-flow, with 22 stages, 11 on each end. The two Allis-Chalmers auxiliary house units are rated at 12,500 kw each, 0.8 power factor 4160 volt, 3600 rpm. Their turbines are of the 30-stage impulse-reaction type.

They inspected the Foster-Wheeler deaerating type, single-pass condensers. These con-

M. G. DRIESSEN ADDRESSING FIRST TECHNICAL SESSION ON THURSDAY

A.S.M.E. Calendar

of Coming Meetings

December 2–6, 1946
A.S.M.E. Annual Meeting
New York, N. Y.

March 2–5, 1947
A.S.M.E. Spring Meeting
Tulsa, Okla.

May 21–24, 1947
A.S.M.E. Oil and Gas Power Division Meeting
Cleveland, Ohio

June 16–20, 1947
A.S.M.E. Semi-Annual Meeting
Chicago, Ill.

Sept. 1–4, 1947
A.S.M.E. Fall Meeting
Salt Lake City, Utah

tain 79,000 sq ft of surface each based on 28-ft tubes 7/8 in. in diameter. Two vertical motor-driven circulating pumps located at the pier-head will be installed with each condenser. Both will be operated normally, having a combined capacity of 152,000 gpm capacity against a 25-ft head.

The fuel-handling system will be capable of receiving coal by barge normally, or by rail in an emergency. Electrically operated barge-unloading cranes will deliver coal to the Bradford coal-preparation equipment, thence by belt to the boiler bunkers. Several other unique features were noted.

Committees

Arrangements for the meeting were capably made by the following committees:

General Committee: N. E. Funk, chairman; H. B. Allen, co-chairman; F. R. Miller, assistant to chairman; L. C. Bosler; Herbert Estrada; A. W. Grosvenor; A. L. Jamieson; Allen J. Johnson; Raymond C. Johnson; Albert G. Kisner; R. W. Leiter; Justin J. McCarthy; Sidney T. Mackenzie; H. Markus; H. W. Montz; Stanley Moyer; M. C. Randall; T. A. Read; H. Rosenthal; A. W. Thorson; Benjamin W. Webb.

Women's Activities: Mrs. Burton F. Keene, cochairman, Woman's Auxiliary, A.S.M.E.; Mrs. John S. Marshall, cochairman, Woman's Auxiliary, A.I.M.E.

Women's Tea Committee: Mrs. Benjamin W. Webb, chairman; Mrs. C. W. E. Clarke; Mrs. J. Page Harbison, Jr.; Mrs. A. L. Bayles; Mrs. J. Stanley Morehouse; Mrs. John A. Fransema; Mrs. Harold I. Robinson; Mrs. William M. Sheehan; Mrs. Allen W. Thorson; Mrs. Franklin Washburn; Mrs. Justin J. McCarthy.

Howard Coonley Elected Head of New International Standards Body

HOWARD COONLEY, associate member A.S.M.E., chairman of the executive committee of the American Standards Association, has been elected president of the new International Organization for Standardization, the formation of which has been completed by delegates from 25 nations meeting in London, Oct. 14 to 26, 1946.

Gustave L. Gerard, staff president of the Belgian Standards Association, will be vice-president of the new international organization which is expected to be known informally as I.S.O. Headquarters will be set up shortly in Geneva, Switzerland, which was chosen in a close final ballot of 12 to 11 over Montreal, Canada.

Formation of the new I.S.O. consolidates into a single organization the work of the old International Federation of National Standardizing Associations (I.S.A.) and that of the war-born United Nations Standards Co-Ordinating Committee. The International Electrotechnical Commission, a third important standardizing agency, is expected to affiliate with I.S.O. shortly as its electrical division.

The members of I.S.O. will be the national standards bodies. Its work will be carried out through technical committees upon which any country may be represented, if it so desires.

The governing body of I.S.O. will be a council containing representatives from 11 countries. Five of these seats are assigned for a period of five years to China, France, Great Britain, U.S.A., and U.S.S.R. Others represented initially on the council are Australia, Belgium, Brazil, India, Norway, and Switzerland.

Following long discussions, which started at preliminary meetings in New York in 1945 and in Paris in this year, the I.S.O. finally agreed to use three official languages: English, French, and Russian. The Russian delegation has pressed vigorously for official recognition of the Russian language.

Technically the new I.S.O. organization is "provisional" and it will be formally completed when its constitution is ratified by 15 national standards bodies. Actually it is starting active work immediately by reviewing the projects and reports of the two predecessor organizations and considering a number of new proposals. The United Nations Standards Co-ordinating Committee will continue in existence and maintain its office in London until the I.S.O. headquarters in Geneva has been established.

Mr. Coonley, is a former president of the National Association of Manufacturers and of the American Standards Association, to which he currently devotes his entire time as chairman of the Executive Committee. He was for many years chairman of the Walworth company and is still a director of that company. During the war he served as director of the conservation division of the War Production Board and, at the appointment of President Roosevelt, he became chief adviser of the Chinese War Production Board.

Mr. Gerard is president of the government-sponsored Institut Belge de Normalisation and was secretary of its predecessor, the Association Belge de Standardisation which was founded in 1919.

The 25 nations represented in the formation of I.S.O. were: Australia, Austria, Belgium, Brazil, Canada, China, Czechoslovakia, Denmark, Finland, France, Italy, India, Mexico, Netherlands, New Zealand, Norway, Palestine, Poland, South Africa, Sweden, Switzerland, United Kingdom, United States of America, Union of Socialist Soviet Republics, and Yugoslavia.

South African Standards Body Honors John Orr

JOHN ORR, member A.S.M.E., chairman for the last 37 years of the South African Standards Institute, the national standardizing body of the Union of South Africa, was elected honorary life president at the eleventh annual meeting of the Institute held in Johannesburg, S. A., in July, 1946.

The office was conferred on Professor Orr in recognition of his services to the South African Standards Institute whose affairs he has guided since 1909.

Detroit Engineers Alive to Civic Responsibilities

NO one can say that the engineers of Detroit, Mich., are not alive to their civic responsibilities. Aware of the inadequacies of the city's transportation system, the Civic Affairs Committee of the Engineering Society of Detroit several years ago recommended to the City Plan Commission that plans for a comprehensive system of transportation be prepared and incorporated into the Master Plan for Detroit.

When the Detroit Common Council gave consideration to two different plans, one prepared by consulting engineers employed by the Detroit Transportation Board, and the other submitted by the Detroit Department of Street Railways, the Civic Affairs Committee scrutinized each plan in the light of future needs of the city and formulated opinions and conclusions which indicated that the proposed plans were not adequate.

C. J. Freund, member A.S.M.E., president, Engineering Society of Detroit, and dean, college of engineering, University of Detroit, presented these conclusions before the Detroit Common Council on the occasion of a hearing for a proposed issue of twenty million dollars of bonds to finance purchase of new street-railway equipment. Dean Freund suggested that inadequacies in the proposed over-all transportation plans might ultimately affect purchase of equipment and said the Engineering Society of Detroit, after a long time study of the problem, was prepared to submit its analysis of the transportation need based on an estimated growth of the city.

As a result of Dean Freund's appearance, a 43-page report prepared by the engineer's Civic Affairs Committee was submitted to all interested parties. The report covered the nature of traffic, the functions of expressways in both private and public transportation, and the long-term requirements of the Detroit downtown area. It contained an evaluation of each plan and a series of recommendations which outlined the "backbone" of a comprehensive ultimate system of transportation for the city. It concluded with the recommendation that a single transportation authority be created to prepare and carry out a fully co-ordinated plan of modernization.

On the strength of this report, the Detroit Common Council appointed a new committee to consider the ideas of the city's engineers.

Thirty-two technical organizations, including the Detroit Section of the A.S.M.E., compose The Engineering Society of Detroit.

President's Page

ANOTHER A.S.M.E. year has been completed with the passing of the 1947 Annual Meeting held in New York. It has been a year of adjustment and reorganization of committees and personnel—a year of constructive peacetime service.

For the first time in five years the improved transportation facilities have made possible almost the normal schedule of National Meetings, Division Meetings, and interchange of visits of officers of our Society.

The Spring Meeting at Chattanooga was a memorable occasion, and the quality of papers and discussion at committee meetings was very high. The entertainment provided by the local committee was in keeping with the fine reputation for Southern hospitality. We extend our thanks to all concerned.

The 1946 Semi-Annual Meeting in Detroit was, as we had all expected, a most successful one and was well attended by a large group of engineers from the Middle West, and because of the Council Meeting and other important sessions, members were present from other parts of the country as well. We all enjoyed the hospitality provided and thank the local committee for the way in which they made our stay pleasant and comfortable.

The 1946 Fall Meeting, held in Boston, was another occasion which did credit to those who were responsible for the arrangements and hospitality. The Governor of Massachusetts opened the session with appropriate remarks at the Monday luncheon, and then followed the usual technical sessions, plant visits, and fine entertainment of the ladies present. We are grateful to New England for this visit.

Time and space will permit me only to list the many other meetings which I have had the pleasure of attending at

Baltimore	Elizabeth	Spokane
Peoria	Los Angeles	Tulsa
Chicago	San Francisco	St. Louis
Cleveland	Portland	Philadelphia
Pittsburgh	Seattle	New York

To the many members of our Society we extend special thanks because all of these visits were most rewarding. Perhaps one of the most valuable results from membership in our Society is found in the friendships which result from work on committees and the interchange of visits which always follow work for the Society.

Special mention should be made of one meeting of the year which was outstanding—the dinner meeting at Los Angeles in July, at which the Holley Medal was presented to Dr. Ernest Orlando Lawrence. Between 600 and 700 prominent engineers and scientists gathered together, with their wives, on this memorable occasion. We are particularly grateful to all who contributed to the success of this great meeting.

The record of the year just closed would not be complete without mentioning the success of the new regional Vice-Presidents' work in setting up the new plan for co-ordinating section, student branch, and other Society activities in each one of our eight geographical regions. We give a word of special appreciation to these Vice-Presidents and would report to the membership our judgment that this new form of organization will mean much to the future success of our Society.

We congratulate the Society on the splendid staff at headquarters that loyally carries the heavy load of management of our affairs. A number of new younger men of ability have been added during the year, and we look with confidence to the future of this growing organization.

The outgoing officers and members of Council salute the new officers who take their places. The opportunities for service of our profession to our country were never more demanding. We confidently expect engineers to meet the challenge of the years of peace that lie before us.

D. ROBERT YARNALL, *President*, A.S.M.E.

E.C.P.D. Reports Progress at Fourteenth Annual Meeting

J. W. Parker, Past-President, A.S.M.E., Elected Chairman

PROGRESS in many broad professional phases of engineering was emphasized in meetings held in New York, N. Y., Oct. 18 and 19, 1946. These comprised the annual sessions of the Engineers' Council for Professional Development. Representatives from eight national engineering societies of the United States and Canada came from various parts of the country to hear reports and to exchange counsel.

To bring the work of engineers before the public, extensive use of public assemblies, the press, and movies should be made. This conviction was asserted by Dean Nathan W. Dougherty of the University of Tennessee, reporting for the Committee on Professional Recognition.

General Acclaim for Profession

Ways and means of attaining professional recognition were detailed in his report in which a plea was made "to all engineers for greater participation in civil and political fields." He stated that in addition to activity in community gatherings the power of the press must not be overlooked. "Excellent books," he stated, "have been written during the last few years on the work of the engineer. Unfortunately, the book-reading public is relatively small in number as compared with those who buy magazines. This field has been neglected by us in late years." To encourage the preparation of articles with popular appeal for such magazines as the *Saturday Evening Post* and *Readers' Digest*, Dean Dougherty suggested "an annual competition sponsored by E.C.P.D., for the ten best papers popularizing the specific work of the author, of a type acceptable to the editors of the national magazines with large circulations."

"Another medium of popularizing is of course the screen," he continued. "Too often the lay public thinks only of the professional engineer as the builder of bridges and skyscrapers. Could we not write specifications for a series of ten-minute films illustrating phases of the making of everyday necessities, each concluding 'March of Time'-wise with 'The luxuries of yesterday have become the necessities of today and are provided by that service-rendering group, the engineers'?"

Recommendations of this committee were:

"More rapid action toward developing a uniform code of ethics; uniform membership requirements and uniform nomenclature for grades of membership in the technical engineering societies; producing a permanent and popular record of engineering achievements during the war; that technical societies through their publications emphasize the professional phases of engineering, and that constituent bodies should use their influence to prevent further multiplication of engineering specialties."

Student Selection and Guidance Studied

Reporting for the Committee on Student Selection and Guidance, Carl J. Eckhardt, Jr., member A.S.M.E., University of Texas, Austin, Texas, pointed out the widespread use of a screening test for pre-engineering students. Called the "Pre-Engineering Inventory," its purpose is to "select engineering students with the expectation which accompanies the selection of materials with which engineers deal." During the 1945–1946 academic year, 32 institutions used the inventory for 12,300 students.

A second screening is proposed with the preparation of "Sophomore Achievement Examinations." These will "serve to reassure those students who should continue their engineering studies." Their usefulness to the college in sampling the needs of their students is quite evident. Proposed, but not yet prepared, are "Senior Examinations" to provide information for graduating students, their educators, and prospective employers. Money for these tests has been made available by The Carnegie Corporation of New York and by the Carnegie Foundation for the Advancement of Teaching, the American Society for Engineering Education, and E.C.P.D.

For the guidance of students aspiring to be engineers, a booklet "Engineering as a Career" was developed by the late Dean Emeritus R. L. Sackett of The Pennsylvania State College and others. To date over 70,000 copies have been distributed through colleges, high schools, professional societies, bookstores, and commercial agencies.

Accrediting Engineering Curricula

At an early date, re-examination of the curricula of all those engineering schools which already had curricula acredited was recommended by the Committee on Engineering Schools. A questionnaire was sent to all such institutions to determine their readiness for such re-examination. Most institutions have replied that because of difficulties encountered in returning to "normal" after the unusual experience of the war years, they would prefer that such inspection be postponed until 1947–1948.

New inspections were at a minimum during the last year. The curriculum in chemical engineering, at the Agricultural and Mechanical College of Texas, was accredited at the annual meeting.

The accrediting of technical institutes is well under way by a committee headed by H. P. Hammond, member A.S.M.E., dean, The Pennsylvania State College. The following curricula at technical institutes were accredited:

Wentworth Institute, Boston, Mass.: Architectural construction, electrical construction, machine construction and tool design, and steam and Diesel engineering.

Bliss Electrical School, Washington, D. C.: Fundamentals of industrial electrical engineering.

Capital Engineering Institute, Washington, D. C.: Practical radio engineering, residence course; and practical radio engineering, correspondence course.

The committee also recommended that a program of accrediting graduate curricula should be inaugurated.

On the factual side, D. B. Prentice, member A.S.M.E., president, Rose Polytechnic Institute, chairman of the committee, reported that out of 167 degree-granting institutions in the United States, 133 now have one or more curricula accredited by E.C.P.D., with a total of 580 curricula accredited in major and specialized fields.

Professional Training Aids Provided

To assist the engineer in his professional development after graduation, the Committee on Professional Training has prepared and circulated a number of aids. In his report, Dr. C. A. Pohl, New York consulting engineer, listed the following: Reading lists and bibliographies, personal appraisal blanks, lists of college extension programs, lists of appropriate articles, and reprints of certain pertinent articles. Dr. Pohl's committee urged closer co-operation between practicing engineers and younger members of the profession, to the end that encouragement and direction be given to the professional development of those entering the engineering profession.

Reference to Engineers Joint Council

The Committee on Employment Conditions for Engineers reported that during the year its chairman, V. T. Boughton, associate editor, *Engineering News-Record*, has studied the activities of the Engineers Joint Council, Committee on the Economic Status of the Engineer, which is actively surveying the compensation of the whole engineering profession. In view of the progress being made by E.J.C. and the doubtful value of duplicating the effort, Mr. Boughton's committee recommended that this group be discharged and the E.C.P.D. request permission to continue to have an observer sit in at meetings of the E.J.C. committee.

The Committee on Principles of Engineering Ethics, under the chairmanship of D. C. Jackson, honorary member A.S.M.E., professor emeritus of electrical engineering at Massachusetts Institute of Technology, reported the development of a universal "Canon of Ethics" for all engineers. The code has been prepared after extensive study of the respective codes of the participating societies and the

draft has been approved by a number of constituent organizations. The final code is expected to be issued soon.

Engineering Societies Listed

The preparation of a list of all engineering societies in the United States (and Canada) was an accomplishment reported by the Committee on Information. Sydney Wilmot, chairman of the committee, reported that 237 organizations had been listed with classification according to "grade of membership subject to admission requirements." This committee also reported the pending publication of the Fifteenth Anniversary Booklet of E.C.P.D.

This booklet has been prepared for dual purposes—information on the activities of E.C.P.D. and the stimulation of contributions to a professional-development-research fund to be administered by the Ways and Means Committee. This program will be under the direction of a special subcommittee headed by R. L. Goetzenberger, member A.S.M.E. vice-president, Minneapolis-Honeywell Regulator Company. This subcommittee reported "that fund-raising is our primary objective to defray the expense of a professional development fund supervised by Engineers' Council for Professional Development. To give meaning to the fund-raising campaign, the committee called for "a listing of projects which require investigations within its scope to perform, and for the accomplishment of which funds are necessary."

The following officers and committee chairmen were elected for 1946–1947: Chairman, James W. Parker, past-president A.S.M.E., president, The Detroit Edison Company; vice-chairman, T. T. Read, professor of mining, Columbia University; secretary, H. H. Henline, national secretary, A.I.E.E.; assistant secretary, A. B. Parsons, secretary, A.I.M.E.; chairman, Committee on Student Selection and Guidance, Carl J. Eckhardt, Jr., member A.S.M.E., superintendent of utilities, University of Texas; chairman, Committee on Engineering Schools, D. B. Prentice, member A.S.M.E., president, Rose Polytechnic Institute; chairman, Committee on Professional Training, Chas. A. Pohl, consulting engineer, New York, N. Y.; chairman, Committee on Professional Recognition, N. W. Dougherty, dean of engineering, University of Tennessee; and chairman, Committee on Information, G. Ross Henninger, editor, A.I.E.E.

Actions of A.S.M.E. Executive Committee

At a Meeting Held at Headquarters Nov. 7, 1946

A MEETING of the Executive Committee of the Council was held in the rooms of the Society, Nov. 7, 1946. There were present: D. Robert Yarnall, chairman, A. C. Chick, D. S. Ellis, R. F. Gagg, J. N. Landis, A. R. Mumford (Sections), Eugene W. O'Brien, president-elect, K. W. Jappe, treasurer, C. E. Davies, secretary, and Ernest Hartford, executive assistant secretary.

Publication of Applied Mechanics Reviews

The secretary reported that a conference, held in Washington, D. C., on Oct. 25, 1946, and attended by representatives of several organizations interested in the publication of applied-mechanics abstracts, resulted in the following recommendations with respect to the proposed publication: (1) That the Office of Naval Research enter into a contract with the A.S.M.E. to support the proposed publication to be called "Applied Mechanics Reviews;" (2) that the A.S.M.E. and the Office of Naval Research, in consultation with five other societies, select an advisory board; and (3) that the advice of this board be sought to aid the A.S.M.E. in the selection of an editor.

A committee composed of John A. Goff, chairman, Committee on Professional Divisions; L. N. Rowley, Jr., chairman, Committee on Publications; and H. Poritsky, chairman, executive committee, Applied Mechanics Division, has been appointed with instructions to recommend a permanent form of organization within the A.S.M.E. to administer the new publication and to arrange for representation of the A.S.M.E. on the proposed advisory board.

American Standards

Upon recommendation of the Committee on Standardization, it was voted to approve the following proposed American standards as standards of the Society and to submit them to the American Standards Association for approval as American Standards: Basic Graphical Symbols for Electric Apparatus (Z32.12–1946); and Abbreviations for Use on Drawings (Z32.13–1946).

1946 Regional Delegates Conference Recommendations

It was voted to adopt statements of the Council actions on the recommendations of the 1946 Regional Delegates Conference. Copies of the statements dated Nov. 7, 1946, have been mailed to all A.S.M.E. Sections.

Qualifications and Duties of Council Members

A revised statement of qualifications and duties of A.S.M.E. Council members, made necessary because of the recent changes in the structure of the Council, was adopted and the secretary was requested to forward it to the 1947 Nominating Committee.

Certificates of Award

The Committee noted that Certificates of Award have been granted to the following retiring chairmen; E. F. Riesing, Rubber and Plastics Division; R. D. Brizzolara, Metals Engineering Division; James H. Potter, Baltimore Section; M. E. Martellotti, Cincinnati Section; H. S. Colby, Cleveland Section; Richard B. Engdahl, Columbus Section; Collins Wight, Dayton Section; A. C. Pasini, Detroit Section; and J. Lawrence Barker, Jr., West Virginia Section.

A.S.M.E. Legal Counsel

Following a report by the secretary concerning recommendation of the U.E.T. Special Committee on Legal Counsel, it was voted to authorize the president and secretary to negotiate with the firm of Carter, Ledyard, and Milburn to act as counsel for the A.S.M.E.

Dean R. L. Sackett

The Committee noted with deep regret the death on Oct. 6, 1946, of Dean R. L. Sackett who had served on the A.S.M.E. staff for over five years. The Committee authorized that an appropriate letter be sent to Dean Sackett's family.

Institution of Mechanical Engineers

The committee noted receipt of a communication from The Institution of Mechanical Engineers in which the A.S.M.E. was invited to appoint two official delegates to represent the A.S.M.E. at the centenary of the Institution which is planned for June, 1947. The president was authorized to appoint two official representatives of the A.S.M.E. to the Institution's centennial celebrations and, if necessary, to address formal greetings in behalf of the Society.

The Hoover Medal

It was noted that the 1946 Hoover Medal has been awarded to Dr. Vannevar Bush and that the medal would be presented to him at the winter meeting of the American Institute of Electrical Engineers in January, 1947.

Resumption of Relations

The Committee noted a communication from the secretary of the Osterreichischer Ingenieur und Architekten-Verein of Vienna, advising of the re-establishment of that society and asking that relations with the A.S.M.E. be resumed. The Committee expressed approval of the resumption of friendly relations.

Appointments

Upon recommendation of the Committee on Organization, it was voted to approve appointments made to A.S.M.E. committees and joint activities for 1946 and 1947. The appointments will be published in full as Part 1 of the February, 1947, issue of the Transactions.

The following appointments were also confirmed: Mervin B. Hogan, to represent A.S.M.E. at the inauguration of the president, University of Utah; N. E. Funk, to represent A.S.M.E. at the inauguration of the president, Lehigh University; and Paul H. Buxton, to represent A.S.M.E. at the annual meeting, National Council of State Boards of Engineering Examiners.

Industrial Designers Elect Officers

RAYMOND F. LOEWY, associate member A.S.M.E., has been elected president of the Society of Industrial Designers for 1947. Other officers elected were: Harold Van Doren, vice-president; Egmont Arens, secretary; and Ray P. Patten, treasurer.

Sixth International Congress Success Despite Travel Difficulties

New Name and By-Laws Adopted

THE importance engineers and scientists place on international fellowship and discussion of scientific problems on an international basis was emphasized by the success of the Sixth International Congress for Applied Mechanics held in the Sorbonne, Paris, Sept. 22 to 29, 1946.

Despite difficulties of arranging a program and the inconvenience of travel, more than 500 engineers and scientists from all over the world registered for the Congress. Although only a fraction of these actually attended the sessions, the Congress accomplished its purpose. Many papers were read and discussed, new friendships were made, old ones renewed, and the groundwork was laid for the Seventh Congress in 1950.

Many Countries Represented

The Congress was held at the University of Paris in its building the "Sorbonne" from Sept. 22 to 29, 1946. The five previous congresses had been as follows:

The first at the Polytechnic of Delft, Holland, 1924; the second at the Polytechnic, Zurich, Switzerland, 1926; the third at the Polytechnic, Stockholm, Sweden, 1930; the fourth at the University of Cambridge, England, 1934; and the fifth at Harvard and Massachusetts Institute of Technology, Cambridge, Massachusetts, 1938.

The Sixth Congress was to have been held in Paris in 1942, and when contact was reestablished in 1944, the French hosts expressed the desire to hold it as soon as feasible. It was held under conditions influenced by the aftermath of the war, not only in the sense that certain comforts were wanting and that travel was quite difficult, but also that no Germans were in attendance. Since Germans were important contributors to all previous congresses, their absence this time was significant. Several hundred invitations had been sent by the French committee to the Russian Embassy, scientific academies, and individuals in Russia, but not a single Russian attended during the first five days. On the fifth day of the seven-day Congress word was received by the French secretary from the Russian Embassy that the Russian delegation would arrive that afternoon. The delegation was official and was to consist of three scientists: Kibel, Kristanovach, and Ilyuskin. They brought papers about which they had not informed the Congress Committee and these were presented in the Russian language.

Other countries were well represented, with some 40 Americans, 30 English, 20 Swiss, 15 Scandinavians, 15 Dutch, a few Italians, Spanish, Czechs, Bulgarians, Turks, Greeks, Chinese, and of course a very large number of French and Belgians. The languages were French and English, predominantly French.

Ninety-Five Americans Register

No exact statistics of the attendance were available. The program printed 525 names of "members," of whom 95 were Americans, but a considerable number of the names so printed were not actually present, and many others registered after the program had gone to press. The program listed 250 papers to be delivered, but a considerable number of these were not presented because their authors were not there and had not designated substitutes. Of the papers actually read at the meetings, close to two thirds were French.

International Committee

The management of the Congress is in the hands of the International Committee, consisting of some 25 individuals, about three from each major country, each being an outstanding person in applied mechanics. The Americans on the Committee are: J. C. Hunsaker, honorary member A.S.M.E., Massachusetts Institute of Technology; Theodor von Kármán, member A.S.M.E., California Institute of Technology; and Stephen P. Timoshenko, fellow A.S.M.E., Stanford University.

The International Committee held two meetings at which the following were present:

France: Villat, president, Sixth Congress; Roy, secretary, Sixth Congress; Cacquot; and Pérés.

United States: von Kármán, member A.S.M.E., and Den Hartog, member A.S.M.E., representing Hunsaker.

England: G. I. Taylor, Southwell, and Goldstein.

Holland: Burgers, Biezeno, and Koning.

Belgium: Van den Dungen. *Switzerland.* Ackeret. *Bulgaria.* Popoff. *No country:* Mises.

New Name Adopted

Before this meeting came a proposal to change the "Congress" into a "Union for Theoretical and Applied Mechanics" to be incorporated into UNESCO, the "United Nations Educational, Scientific, and Cultural Organization." After considerable debate, this proposal was adopted, and a set of by-laws established which provide that the new Union is to be governed by a "Council;" that the membership of this Council consist of the former International Committee; and that new members of this Council can be appointed only by the Council itself and not by any other agency, whether United Nations, governmental, or academic. Further, it was provided that an honorary secretary was to be appointed by the Council, his duty being to act as a receiver and forwarder of correspondence. This post is to be held for the next four years by Prof. J. M. Burgers of the Polytechnic, Delft, Holland.

New Members

The new Council then proceeded to the election of new members, mostly to replace vacancies by death or retirement during the eight years since the last Congress. These new members are as follows:

United States, H. L. Dryden, member A.S.M.E., Bureau of Standards (fourth U. S. member); Britain, Goldstein to replace Bairstow, who retires; France, Cacquot and Pérés to replace Jouguet and Hahn; Switzerland, Favre to replace Stodola; Sweden, Weibull to replace Ossen; Holland, Koning to replace Wolff; Turkey, Erim to replace Mises, who is now in the United States; China, Ku and Chou, new members; No country, Mises (now in the United States, formerly Turkey and Germany) and Sverdrup (now in United States, formerly Norway).

No action was taken on the members for Germany, Italy, or Russia.

The time and place of the next (seventh) Congress were discussed. It was voted to hold it in 1950, but the location would be decided by correspondence in about two years, when the general conditions of the world presumably would give a better basis for a proper choice. Switzerland was mentioned as a possible location, because as a neutral in this war it would be in a better position than any other country to invite German participation.

Look Magazine Hails E.J.C. Reports on Germany and Japan

THE programs for the control of German and Japanese industry, formulated by the Engineers Joint Council, are the basis of a five-page lead article in the Christmas Issue of *Look Magazine*, which is scheduled to reach newsstands Dec. 10, 1946.

The article, which relies principally on photographs and drawings to tell its story, credits American engineers with originating a "war detection" plan which if adopted by the principal nations would serve to remove fear and suspicion from world diplomacy and thereby encourage general disarmament.

Copies of the article, which *Look Magazine* titles, "Peace on Earth—Dream or Possibility?" are being sent to representatives of the United Nations, currently in session in New York, N. Y.

"Controls worked out by the engineers for Germany and Japan," the article states, "specifically prohibit certain types of manufactures. Other products are severely limited. The technique of war detection is included in the program as its long range safety factor—to reveal automatically any future secret rearmament by the ex-enemy states. *Look* proposes that the war detection technique, now in effect in Germany and Japan, be seriously considered for the whole world."

Of the fifty engineers who worked on the E.J.C. reports the photographs of eight are a part of the article.

The E.J.C. is sponsored by the American Society of Civil Engineers, the American Institute of Mining and Metallurgical Engineers, The American Society of Mechanical Engineers, the American Institute of Electrical Engineers, and the American Institute of Chemical Engineers.

An account of the E.J.C. reports for the control of German industry was published on pages 754–756 of the November, 1945, issue of MECHANICAL ENGINEERING.

New A.S.M.E. Publications Available

THE following standards, recently published by The American Society of Mechanical Engineers and approved by the American Standards Association, are available and may be obtained by writing to The American Society of Mechanical Engineers, Publication Sales, 29 West 39th Street, New York 18, N. Y.

"Gear Tolerances and Inspection B6.6–1946." This standard suggests definite inspection methods and tolerances and is intended for use as a practical basis for the manufacture, inspection, sale, and purchase of gears. Price $0.80.

"Life Tests of Single-Point Tools Made of Materials Other Than Sintered Carbides B5.19–1946." This standard suggests test methods for the appraisal of single-point cutting tools other than those of sintered carbide for use on such machine tools as lathes, turret lathes, boring mills, planers, and shapers. Price $0.55.

New Board to Co-Ordinate Federal Activities in Science

PRESIDENT TRUMAN established on Oct. 17, 1946, a new government co-ordinating agency, the Presidential Research Board, and charged it with the responsibility of assuring that Federal activities in the field of science were being administered in the national interest.

The new board is believed to be an executive substitute for the proposed National Science Foundation which Congress failed to pass during the closing days of the last session.

Composed of cabinet members and other high Federal officials, the twelve-member board was created by Executive Order 9791. John R. Steelman, director, Office of War Mobilization and Reconversion, was named as its head.

In a statement accompanying the order, the President said: "National security and the development of the domestic economy depends upon the extension of fundamental scientific knowledge and the application of basic principles to the development of new techniques and processes."

"The nation has a vast reservoir of war-accelerated technological development which must be applied speedily and effectively to the problems of peace, stepping up productivity in both industry and agriculture, creation of new farm and factory products, and advancement of medical science. Fundamental research, necessarily neglected during the war, must be resumed if scientific progress is to continue."

Members of the board, in addition to Mr. Steelman, are the Secretaries of Agriculture, Commerce, Interior, Navy, and War; the Federal Loan and Federal Security administrators, the chairmen of the Federal Communications Commission, Tennessee Valley Authority, and National Advisory Committee for Aeronautics, and the director of the Office of Scientific Research and Development.

300 Attend Conference on Hydraulic Machinery

THE second National Conference on Hydraulic Machinery was held at the Continental Hotel, Chicago, Ill., Oct. 22 and 23, 1946. Approximately 300 persons attended the two-day meeting which dealt with fundamental aspects and recent developments in the field of industrial hydraulics.

The conference was sponsored by the Armour Research Foundation and the Graduate School of Illinois Institute of Technology in co-operation with the Western Society of Engineers, and the local sections of the American Society of Civil Engineers, The American Society of Mechanical Engineers, and the Society of Automotive Engineers. The program consisted of four technical sessions at which eleven papers were presented.

The first session was opened by V. L. Streeter, member A.S.M.E., chairman of fluid mechanics and thermodynamics at the Armour Research Foundation, and chairman, 1946 Hydraulics Conference. Dr. Streeter's paper was concerned with losses in fluid flow when fluid is conveyed from one place to another through conduits, ports, valves, or fittings and the methods of expressing these losses in a form useful for design purposes.

O. E. Teichman, member A.S.M.E., research professor, Armour Research Foundation, presented a paper on "Consequences of Newton's Viscosity Law."

At the concluding session it was announced that the 1947 Conference will be held in Chicago, Oct. 16 and 17, 1947. It will called the National Conference on Industrial Hydraulics.

W. R. Whitney Calls Bacon Father of Research

FRANCIS BACON, sixteenth-century philosopher and author of "The New Atlantis" can be credited with the origin of the idea of organizing world research for the public good, according to Willis R. Whitney, organizer and first director of the Research Laboratory of the General Electric Company.

Dr. Whitney spoke before a dinner meeting of the Industrial Research Institute at the Westchester Country Club, Rye, N. Y., Oct. 17, 1946. Dr. Whitney was presented the first I.R.I. Award in recognition of his contributions to the field of industrial research.

Referring to "The New Atlantis" in which Bacon described a scientific Utopia, Dr. Whitney urged engineers and scientists to read Bacon's little book because "it foreshadowed most of the valuable discoveries which the years have now exposed."

"The natural development of Bacon's ideas," Dr. Whitney continued, "led to the early establishment of academies and societies of science in all countries and they still increase. But the important and encouraging aspect is that they early began world-wide co-operation as though knowledge was a universal asset. Today, except when there is war, international comity and close communication between all scientists is common. That should be looked upon as the forerunner of permanent world peace."

The Industrial Research Institute is a company-membership organization founded in 1938 under the auspices of the National Research Council to promote improved management of industrial research, to develop an understanding of research as a force in the life of the nation, and to promote high standards in the field of industrial research. In 1945, it was incorporated in the State of New York as a nonprofit corporation. It now includes 83 member companies representative of widely diversified types of industry and of the industrial areas of the country.

Engineers Participate in C.E.D. Projects

THE engineer's point of view on problems of American economy is made available to the Committee for Economic Development by three A.S.M.E. members who are among the 95 educators, economists, and businessmen on the C.E.D. board of trustees.

These members are: Ralph E. Flanders, past-president and honorary member A.S.M.E., chairman, Jones and Lamson Machine Company, Springfield, Vt.; George S. Armstrong, member A.S.M.E., president, George S. Armstrong and Company, Inc.; and William McClellan, chairman of board, Union Electric Company of Missouri, St. Louis, Mo.

The C.E.D. was organized in September, 1942, by leaders of American economic thought, in order to develop through research those economic policies which could contribute most to the solution of the immediate postwar problems of business, and to the strengthening of the American competitive position with respect to foreign economic theories.

The work of the C.E.D. was explained recently to 70 business editors at a luncheon given by the C.E.D. at the Waldorf-Astoria Hotel, New York, N. Y.

Theodore O. Yntema, director of research of the C.E.D., outlined 15 projects undertaken by the C.E.D. and explained how the work of independent scholars and the practical "know-how" of business leaders are concentrated on the study of specific economic problems. He showed how the opinions of both are made available to business leaders in the form of book-length research reports by independent economists and in statements on national policy by the C.E.D. Committee on Research and Policy.

Dr. Yntema said that what happens to the United States during the next few years may determine the history of the American people and the peace of the world for many years. He said:

"We work on the theory that what is good for the country is good for business, rather than the other way around. We are trying to treat these problems objectively, for example, not merely to raise the profits of business but to raise the standard of living of the American people.

"We are centering our research right now on collective bargaining, wage-price policy, and other phases of labor-management relations

because we want to promote industrial peace for everybody's sake. It is in the public interest to avoid interruptions of production while labor-management disputes are being settled."

John H. Van Deventer, president and editorial director, *The Iron Age*, New York, N. Y., who introduced Dr. Yntema, said that the aim of the C.E.D. was to reduce the "economic illiteracy" of the American people. He expressed as his personal opinion the belief that the American democracy might not be able to survive another major depression such as the one which began in 1929.

Mr. Van Deventer said that the Russians were waiting for the next depression in the United States so that communism could take over here.

Faculty Changes at Ohio State University

AUBREY I. BROWN, member A.S.M.E., has been appointed head of the department of mechanical engineering at The Ohio State University, Columbus, Ohio. He succeeds Franklin W. Marquis, member A.S.M.E., who resigned the chairmanship to devote full time to teaching.

Eric J. Lindahl, member A.S.M.E., who has returned to the staff after a year's leave of absence, has been promoted to associate professor.

Professional Employees Plan New National Organization

TWENTY representatives of associations of professional employees from several cities on the Pacific Coast met in San Francisco, Calif., on Oct. 5 to 7, 1946, for the purpose of organizing a national professional employees association.

The associations represented at the meeting were independent organizations composed of engineers, architects, industrial scientists, and similar employees, which had been organized on a local basis to promote the economic welfare and professional status of their members and to protect their right to bargain collectively through agencies of their own choosing.

The aim of the proposed national association is to unite the local associations in one organization for mutual aid in solving common problems and for the advantages of unified action in the effort to attain nation-wide recognition of their objectives.

Basic questions of policies, objectives, qualifications for membership, structure of the organization, and scope of activities were discussed. A committee was chosen to draft a constitution for submission to the constituent organizations.

The name adopted for the proposed organization was "National Professional Association of Engineers, Architects, and Scientists."

Oscar G. Goldman, member A.S.M.E., is member of the executive Committee of the San Francisco Area Group of Professional Employees, which was the host organization at the meeting.

Magnesium Industry Predicts Lower Costs

WIDER use of magnesium and a gradual reduction in manufacturing costs of magnesium products were predicted at the Third Annual Meeting of the Magnesium Association and the First International Magnesium Congress held at the Waldorf-Astoria Hotel, Oct. 3 and 4, 1946.

"Costs should come down," said J. D. Hanawalt, general manager, magnesium division, The Dow Chemical Company, "when a reasonably large and steady volume of production has been attained and new processing developments are more fully utilized." Dr. Hanawalt, who spoke on "Magnesium's Tomorrow," pointed out that present costs are due to small-scale production methods for cast, wrought, and fabricated forms of the metal rather than to initial cost of the ingot."

Dr. Hanawalt emphasized that metallurgical discoveries will not bring large volume overnight, although many promising experimental developments such as electroplating, cladding, and brazing of magnesium, and new alloys, will undoubtedly help the growth of the industry. The attainment of a volume of demand sufficient to warrant continuous sheet rolling and automatic handling of the molten metal in foundries and die-casting plants will come through sound engineering of magnesium into a wide variety of products in the industrial and consumer fields. The metal has already proved both serviceable and economical in many applications such as griddles, ladders, baby strollers, sporting goods, and industrial equipment, as well as in the well-established aircraft field.

"Use of the metal in commercial products," Dr. Hanawalt stated, "is rapidly increasing as designers and engineers become more familiar with its outstanding combination of lightness with other desirable properties, and consumption of magnesium in fabricated forms this year is expected to be well over ten times the prewar volume."

Atomic Energy Commission Appointed by President

DAVID E. LILIENTHAL, chairman, Tennessee Valley Authority, was named by President Truman as chairman of the Atomic Energy Commission created by the Atomic Energy Act of 1946.

Other members named to the five-man full-time civilian board were: Lewis L. Strauss, a banker; William Wesley Waymack, an editor; Robert Fox Backer, an atomic physicist; and Somner T. Pike, a businessman.

In making his announcement President Truman said, "The Commission will take over properties and an organization which, in magnitude, are comparable to the largest business enterprises of the country. There is no activity—government or business—upon which the security and the enrichment of our nation are more heavily dependent."

The Atomic Energy Commission will have power over atomic patents, atomic raw materials, lands producing uranium, thorium, and atomic weapons. Its decisions will be subject only to the veto of the President.

Following its appointment, the first official act of the Commission was a statement in which it said that the Commission would take over the Army's atomic project "with a minimum of interruption and dislocation," and that "the orderly transfer of functions and properties from the Manhattan Engineer District" would be extended over a period of months.

A summary of the Atomic Energy Act of 1946 was published on page 919 of the October issue of MECHANICAL ENGINEERING.

Home Research Laboratory Planned by University of Illinois

THE Small House Council of the University of Illinois, Urbana, Ill., is planning the construction of a Home Research Center at which the arts and sciences as applied to housing can be studied. The Home Research Center will not be used as a laboratory for testing materials, but for the investigation of principles of housing, such as those involved in land use, community planning, architectural design, home economics, sociology, and psychology.

The Center, when completed, will provide facilities for work in all phases of housing research and education. It will include a main building, a production yard, and several research houses. The main building will house a large laboratory in which the theoretical phases of research will be carried on. The production yard will be a wide outdoor area where partial structures or experimental houses can be built as actual site operations, and where educational activities for contractors and building craftsman can be conducted.

The Center will also have complete homes in which specific problems of housing improvements will be studied under practical operating conditions.

United Engineering Trustees, Inc., Elects Officers

J. P. H. PERRY, vice-president, Turner Construction Company, New York, N. Y., was re-elected president of the United Engineering Trustees, Inc., at a meeting of the Corporation in the Engineering Societies Building, New York, N. Y., Oct. 24, 1946.

Mr. Perry has been affiliated with the United Engineering Trustees, Inc., for many years. He has been a director for eleven years, a vice-president for three years, and has served on the Engineering Foundation Board for four years.

Other officers elected were: Ralph M. Roosevelt and Wm. H. Harrison, vice-presidents; Albert Roberts, treasurer; C. R. Jones, assistant treasurer; and John H. R. Arms, secretary.

United Engineering Trustees is a corporation set up jointly by the four national engineering Founder Societies. These are: American Society of Civil Engineers, American Institute of

Mining and Metallurgical Engineers, The American Society of Mechanical Engineers, and American Institute of Electrical Engineers.

The Corporation promotes the advancement of the engineering arts and sciences in all their branches, through two departments, the Engineering Foundation and the Engineering Societies Library. The Corporation currently has total assets of nearly three and a half million dollars, not including the value of its Library, and is facing a program of expansion to keep pace with increasing demands upon it. The Corporation is the titular owner of the Engineering Societies Building and of the trust funds of the Library, the Foundation, the John Fritz Medal Board of Award, and the Daniel Guggenheim Medal Board of Award.

Ralph H. Flanders Named to U. S. Senate

RALPH H. FLANDERS, past-president and honorary member, A.S.M.E., Worcester Reed Warner Medalist, 1934, and chairman, Jones and Lamson Company, Springfield, Vt., was appointed to the United States Senate to fill the vacancy created when Warren R. Austin resigned to become the American Representative to the United Nations Security Assembly. The appointment became effective Nov. 1.

Governor Mortimer R. Procter made the appointment late in October in order to give Mr. Flanders, who was the Republican nominee for the Senate, some seniority rights over the senators elected on November 5. Mr. Flanders was elected to the Senate on November 5.

The appointment was made possible by an act of the Vermont legislature in special session last month. Until then the Vermont statutes had prevented the governor from filling the vacancy.

A.S.C.E. Nominates 1947 President

EDGAR M. HASTINGS, chief engineer, Richmond, Fredericksburg, and Potomac Railroad Company, Richmond, Va., was nominated as the 1947 president of the American Society of Civil Engineers at the fall meeting of the Society's board of direction in Kansas City, Mo.

He will take office at the A.S.C.E. annual meeting in January, 1947.

Power Industry Honors George Westinghouse

GEORGE WESTINGHOUSE, past-president and honorary member A.S.M.E., if he were alive today would still find his greatest opportunities in the field of power, but his first concern would be the power of the human mind and spirit rather than the power of machinery.

This opinion was expressed by Gwilym A. Price, president, Westinghouse Electric Corporation, in a talk, "Interdependence—Then and Now," made at the George Westinghouse Centennial Luncheon, Hotel Astor, New York, N. Y., Oct. 2, 1946. The luncheon was sponsored by the Electrical and Gas Association of New York as part of the Eleventh Annual Conference of the International Association of Electrical Leagues to honor the 100th anniversary of the birth of George Westinghouse.

Mr. Price said that George Westinghouse advanced civilization by his contributions to the safety of transportation and to the transmission and use of natural gas and electricity, and by his development of the steam turbine, and that in doing so, he accelerated the interdependence of men and nations.

"Even one-hundred years ago," said Mr. Price, "interdependence was a reality. Today, due so largely to George Westinghouse and his able contemporaries, interdependence is the supreme reality of existence—to every race and nation, to every group and every individual."

Referring to the interdependence between employer and employee Mr. Price stated, "I believe that management must spend even more time and energy in developing the full potential of our individual employees than we have devoted in the past to utilizing technical knowledge and machinery. The human potential can be best developed through improved appreciation of mutual interest. Its development requires the elimination of misinformation and misunderstanding, the eradication of conflict and cross-purpose."

If George Westinghouse were to face the industrial problems of 1946, Mr. Price indicated, he would not try to remake all the world all at once, but would begin at the beginning and would attack the problem at the point of his own responsibility—in his own business, in his own relationships with his associates, his employees, and the unions which represent them.

Sections

Akron-Canton Section Hears Talk on the Profilometer

A MEETING was held on Oct. 3 in the Y.W.C.A., Akron, Ohio. The speaker was Ernest J. Abbott, member A.S.M.E., president and general manager, Physicists Research Company, Ann Arbor, Mich., who gave a talk entitled "Profilometer and Shop Measurement of Surface Finishes." Mr. Abbott described the application of the profilometer in increasing production efficiency and quality in the manufacture of the profilometer and its associated instruments. Twenty seven were in the audience.

Two October Meetings Held by Atlanta Section

At the Atlanta Athletic Club, Atlanta, Ga., on Oct. 11, 34 members met with E. E. Williams, vice-president, A.S.M.E. Region IV, for lunch, to hear the results of his recent trip into Texas, Mississippi, Louisiana, and Tennessee, covering meetings with several of the sections, and particularly with college students.

On Oct. 22 at Georgia School of Technology, Prof. Carl J. Eckhardt, Jr., member A.S.M.E., spoke on "Responsibility of Professional Engineers in Selection and Guidance of Engineering Students." This talk was given before 150 members of the student body. Previous to the lecture, Professor Eckhardt was entertained at a luncheon, at which Dr. Van Leer, president, Georgia Tech, and Eugene O'Brien, president-elect, A.S.M.E., were also present.

"Compression Distillation" Talk at Boston Section

The meeting on Oct. 17 at Northeastern University, Boston, Mass., presented talks by Dr. R. V. Kleinschmidt and by B. Allen Latham, member A.S.M.E., of Arthur D. Little, Inc. Dr. Kleinschmidt showed the application of the reversed heat-pump cycle as a means of compressing low-pressure vapor with a small pressure differential to the distillation of water. He explained the remarkably greater yield of this method over the conventional multiple-effect evaporator, the compactness of the system, and its application to submarines, boiler feedwater, and other purposes. Slides of the performance and equipment were shown. An open discussion was conducted by both speakers after their talks.

Central Indiana Hears How Indianapolis Fights Smoke

On Oct. 18 at the Athenaeum, Indianapolis, Ind., Chas. S. Frost, assistant combustion engineer, City of Indianapolis, gave a talk entitled "Indianapolis Fights Smoke." Mr. Frost said that smoke increases the laundry and cleaning bills of the city $750,000 a year, painting $65,000, and electric light $37,500. The community, morale, health, financial and educational aspects were discussed, followed by motion pictures of what has been accomplished to date. An interesting open forum concluded the meeting, attended by 75.

Central Pennsylvania Hears Prof. E. R. Queer

On Oct. 29 a meeting was held at The Pennsylvania State College, State College, Pa., attended by 50 members and guests. Prof. E. R. Queer spoke on "Dehumidification Protects Navy's Inactive Fleet." He explained that dehumidification is the chief factor in preservation, provided the relative humidity is maintained at 30 per cent. Atmospheric moisture is the chief destructor of ships in storage. Dynamic dehumidification is used for the most part since it is automatic in its operation. The requirements for such a system are: (1) Little servicing; (2) long life; (3) ships can be made ready for use in a

short time. Professor Queer's talk was accompanied by a film.

Cincinnati Section Meets With A.S.M.

A joint meeting with A.S.M. was held on Oct. 10 at the Engineering Societies Building, Cincinnati, Ohio. Dinner was followed by the showing of a popular film, and later E. A. Hoffman, of the LaSalle Steel Company, guest speaker, gave a talk to an audience of 110, on "Gears: Material Selection and Heat-Treatment." Mr. Hoffman discussed metallurgical factors affecting selection of steels; surface hardness, hardness gradient, core properties, and wear characteristics, the practical applications of induction-hardened gears in industry, including coil design, mechanization for production, and quenching technique. He showed design characteristics as related to strength of the hardened case, by means of slides. A lively and interesting question period followed.

An exchange meeting with the West Virginia Section A.S.M.E. was held on Oct. 18. Luncheon and dinner were served in the Daniel Boone Hotel, Charleston, W. Va. The story of this meeting is told on page 1104 of this issue as reported by the West Virginia Section.

Coal-Burning Motive Power Subject at Cleveland Section

At the Oct. 10 meeting in the Cleveland Engineering Society building, Cleveland, Ohio, Kenneth A. Browne, member A.S.M.E., of the Chesapeake and Ohio Railroad Company, spoke on "Modern Coal-Burning Motive Power." This was an illustrated talk, covering the development of the steam locomotive during the past few years and the possibility of using gas turbines burning pulverized coal in the future. Forty members and guests were present.

Diesel Freight Locomotives Topic at Colorado Section

On Oct. 11 at the Oxford Hotel, Denver, Col., J. H. Whipple, Jr., member A.S.M.E., superintendent Diesel department, Denver and Rio Grande Western Railroad Company, gave a talk on "Construction and Performance of 5400-Hp Diesel Freight Locomotive." The speaker gave a brief description of the early development of the Diesel engine and its application to railway work and a detailed description of present equipment and its operation, particularly the equipment as furnished by the electric motive division of General Motors. The talk was illustrated with sound movies and slides. Thirty three attended the meeting.

Detroit's Mayor Speaks Before Detroit Section

A "ladies' night" meeting was held on Oct. 8 in the Horace H. Rackham Memorial Building. Following the dinner, an interesting talk was given by Dr. Icie Macy Hoobler, director of research laboratory for the Children's Fund of Michigan. The subject was "The Romance of Research in Nutrition." Later, in the main auditorium, Hon. Edward J. Jeffries, Jr., mayor of the City of Detroit, spoke to an audience of 400 on "Problems of the City of Detroit." After the talk, the Mayor very graciously answered questions about the policies of his administration.

East Tennessee Section Resumes Meetings

On Oct. 11 at the Chattanooga Golf and Country Club, Chattanooga, Tenn., Buford H. Martin gave a talk before an audience of 65 on "Reverse-Cycle Refrigeration for Heating."

Fort Wayne Section Has Dinner Meeting

On Oct. 3 in the Old Fort Room, Indiana Hotel, Fort Wayne, Ind., Henry Stone and Lewis Haffner, field engineers representing the Fellows Gear Shaper Company, were the guest speakers. Their talks on "The Art of Generating Gears and Gear-Manufacturing Equipment," were illustrated with a 16 mm sound and movie film. This was a dinner meeting, and a group of fifty attended the technical session following.

Albert R. Mumford Speaks at Ithaca Section

On Oct. 28 at the Arlington Hotel, Binghamton, N. Y., Albert R. Mumford, fellow A.S.M.E., vice-president-elect, A.S.M.E. Region II, gave a talk entitled "The Relation of the Members to the Engineering Society." Mr. Mumford said that he feared the loss of professional identity by engineers as industry tends to absorb them into an undifferentiated mass of salaried employees, and organized labor seeks to regiment them into bargaining units. Thirty four were present.

Fairfield County Section Has Dinner Meeting

A dinner meeting was held on Oct. 17 at the Barnum Hotel, Bridgeport, Conn. The program consisted of a talk on "Jet Propulsion," by Charles L. Fay, manager of flight research, Bell Aircraft Corporation, Niagara Falls, N. Y. Mr. Fay said that jet propulsion, one of the outstanding technical developments of the war, has not yet reached the point where it is practical enough to compete with normal services provided by commercial air lines for reasonably short distances. He pointed out that the jet-propulsion engine can burn any fuel of reasonable volatility and heat content, from shellac to brandy. He added that one of the prime drawbacks in the early development of jet propulsion was inability of metallurgists to perfect a metal to withstand heat, generated by the jet engine, but now that such metals have been perfected there is no limit to speed and efficiency of jet-propelled engines. In pointing out the disadvantages of jet propulsion, Mr. Fay described the extremely high quality of materials required and nonadaptability to small units, as factors retarding development of jet propulsion. Following the talk, a motion picture of the development of jet propulsion was shown, and the story of the Bell helicopter was shown in color. One hundred and twenty were in the audience.

"History of Power" Talk at Louisville Section

On Oct. 24 at Parkmoor Recreations, Louisville, Ky., A. G. Rosenbaum, member A.S.M.E., superintendent of power, Louisville Gas and Electric Company, spoke on "History of Power" to 45 members of the student branch at the University of Louisville and the local Section. The talk was of a general nature, tracing the development of power from early history.

A.S.M.E. Vice-President Guest of Memphis Section

The Section presented Edward E. Williams, vice-president, A.S.M.E. Region IV, at the Engineers' Club luncheon, in the Hotel Peabody, Memphis, Tenn., on Oct. 7. Mr. Williams spoke before an audience of 123, on "Fundamental Considerations Involved in the Organization of a National Society to Represent All Engineers." He was received with enthusiasm and over 50 remained after the meeting was adjourned, for an informal discussion with the speaker. The same evening Mr. Williams was guest of the Section at a dinner at the University Club. The members were enthusiastic over Mr. Williams and want him to speak again.

Forceful Speaker at Milwaukee Section

At the City Club, Milwaukee, Wis., on Oct. 9, Dr. R. A. Kirkpatrick of the Union Pacific Railroad, gave a talk on "Harnessing the Colorado." Dr. Kirkpatrick, well-known lecturer, author, and educator, has spent many months exploring and photo-

SPEAKERS AT THE OCT. 9 MEETING OF THE A.S M.E. MILWAUKEE SECTION

(*Left to right:* Sebastian Judd, member, board of directors, Milwaukee Section; R. A. Kirkpatrick, Union Pacific Railroad; and Max Ruess, chairman, A.S.M.E. Milwaukee Section.)

graphing the Colorado Canyon and the adjacent watersheds. He told a tremendous story of man's battle to control the Colorado River and the building of Boulder Dam, illustrated with colored slides. The audience of 120 agreed that Dr. Kirkpatrick was a forceful and moving speaker. Before the program a "ladies' night" dinner was enjoyed.

Civil Engineer Speaker at New Orleans Section

On Oct. 29 a meeting was held in Maylie's Restaurant, New Orleans, La. The speaker was Chas. M. Kerr, civil engineer, who gave a talk entitled "Planned Future Industrial Development in the New Orleans Area." Mr. Kerr outlined the advantages of the New Orleans area as a location for various industries. Particular emphasis was placed on the area fronting on the inner harbor canal connecting the Mississippi River with Lake Pontchartrain. He also reviewed the number of new industries which have recently located in the New Orleans area. Thirty two were present.

Atomic Energy Subject at New Haven Section

The meeting on Oct. 9 at Ceriani's Cafe Malone, New Haven, Conn., featured Ernest C. Pollard, associate professor of physics, Yale University, who spoke on "Atomic Energy as a Source of Power." Professor Pollard discussed briefly the physics of a chain reaction and described a pile which could be used to produce power commercially. He mentioned a number of problems which would be encountered, such as the development of suitable materials, development of safety precautions, etc. The talk was followed by a lengthy question and discussion period which indicated great interest on the part of the audience. The speaker made a strong plea for a release of some of the government secrecy in order to permit full private development. Forty nine were present.

New London Section Hears Wendell Kinsey

At the Oct. 23 meeting in the Mohican Hotel, New London, Conn., the topic discussed was "Atomic Energy Problems," and the speaker, Wendell Kinsey. He gave the historical background to atomic physics, beginning with Benjamin Franklin and leading up to the work by Bohrs and Urey. The problem of control of the fission process, together with the necessary shielding for generating personnel, disposal of radioactive cooling medium, and chemical refinement of the used fission materials, was brought out. Thirty two were in the audience.

Ontario Section Hears Dr. C. R. Austin

On Oct. 10 at Hart House, University of Toronto, Toronto, Can., Dr. C. R. Austin, vice-president, Meehanite Metal Corporation, gave a talk entitled "Better Castings for the Mechanical Engineer." Dr. Austin dealt with the engineering properties of the various grades of Meehanite as compared with the steels and grey irons. Common faults in casting design were discussed and the remedy for same given. The necessity of giving full information to the foundry regarding proposed application of castings was stressed. Slides and a film illustrated the talk. There was an audience of 100 to hear Dr. Austin.

"Petroleum Refining" Talk at Philadelphia Section

On Oct. 22 at the Philadelphia Engineers Club, Philadelphia, Pa., Dr. E. R. Smoley gave a talk to an audience of 125, on "Development in Petroleum Refining." The speaker covered a review of petroleum resources in the Western hemisphere and a complete description of the improved refining methods, new processes, and new products derived from petroleum.

Raleigh Section Hears Talk on Head-End Power for Passenger Trains

AT a meeting of the A.S.M.E. Raleigh Section at the Cape Fear Club, Wilmington, N. C., on Oct. 26, J. D. Loftis, general superintendent, motive power, Atlantic Coast Line Railroad Company, spoke on "Head-End Power for Streamlined Passenger Trains."

Mr. Loftis reviewed the evolution of passenger-car lighting and heating from the early days of railroads and showed how improvements in passenger service have increased the electric-power load on modern trains. He said that the current electric-power requirements on trains justify use of one generating station at the head of the train and the transmission of electric power to cars instead of generation of power from the axles of individual cars.

Mr. Loftis reported in detail a study by his company of an all-electric eighteen-car train. He said the power requirements of such a train are equivalent to the power demand of a town of 1500 population.

The study showed that the engineering problems associated with illumination, air-conditioning, and refrigeration on passenger trains have already been solved by equipment manufacturers and that the main job still to be done is the application of these engineering accomplishments into the design of the all-electric train.

Mr. Loftis concluded by saving that his company has given serious consideration to the installation of the head-end system in cars now being constructed but because of the limited time available for its development, it has not yet been included.

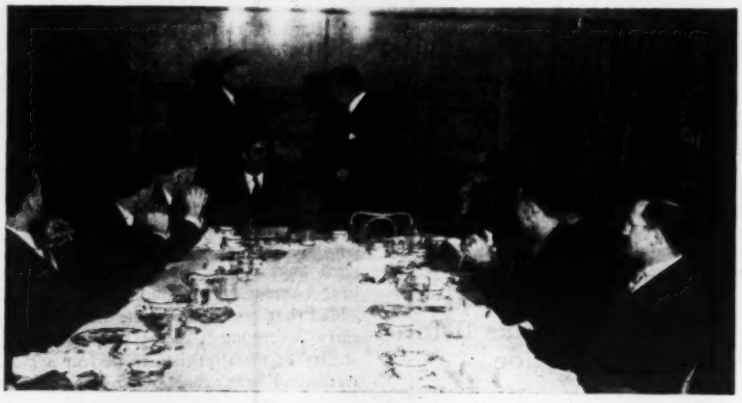
Tool Wear Discussed at Providence Section

On Oct. 2 at the Providence Engineering Buildings, Providence, R. I., a talk was given by G. P. Witteman, entitled "Specific Studies Pertaining to Tool Wear." Mr. Witteman explained the chip characteristics and surface finish of free cutting steels, and illustrated with slides. He told of the effect of boron and nitrogen on the various constituents of steels and gave cases illustrating how increases in hardening elements will affect machinability. He said that the variables which affect cutting performances are estimated to run into a high figure. Twenty-three members and guests were present.

Dinner Meeting Opens Season for St. Joseph Valley Section

On October 15 the winter season was opened with a dinner meeting at the Whitcomb Hotel in St. Joseph, Mich. The group had the unexpected honor of having T. S. McEwan, vice-president, A.S.M.E. Region VI, in attendance, and he was called upon to present service awards to O. E. E. Zahn, L. E. Waddington, and C. R. Egry.

Threatened labor difficulties prevented the chairman from being present and in his absence R. C. McNeile, secretary-treasurer, presided. After the usual business of the minutes and announcements, he turned the meeting over to the editorial department of *Industry and Power*. The subject was financing, editing, and distributing a technical trade



DINNER MEETING OF THE A.S.M.E. ST. JOSEPH VALLEY SECTION, OCT. 15

magazine. Actual drafts, galley proofs, and pasteups were shown to illustrate the "mechanics" of getting out the book. H. E. Hollensbe, editor, pointed out some advantages to engineers in submitting articles to trade journals, as well as giving suggestions on how to prepare them for editorial acceptance.

Following the program, the group visited the printing plant to watch linotype operations and one- and two-color presses in operation.

Modern Gearing Discussed at Rock River Valley Section

On Oct. 24 at the Hilton Hotel, Beloit, Wis., "Trends in Modern Gearing" was the subject chosen by the speaker, Walter P. Schmitter. He showed modern methods of design of gearing, illustrated with diagrams on slides; types of metals used, and methods of forming and finishing teeth; standardization of gears for production, and examples of various types of gear units. A lengthy discussion period followed, with the 46 present participating generally in the discussion.

San Francisco Section Meets With Pacific Railway Club

The first fall meeting was held on Sept. 26 as a joint session with the Pacific Railway Club. The speaker was C. D. Allen, manager, transportation sales, Pacific Coast Division, Baldwin Locomotive Works, whose subject was "Current and Proposed Locomotives for Modern Transportation." Mr. Allen urged that other forms of transportation be required to pay their proportionate share of taxes in support of government, and that government expenditures for transportation facilities should be subject to the same tests as to public convenience and necessity and economic justification, as are applied to private expenditures for similar purposes. He then told of the successful tests of the S-2 geared-turbine locomotive by the Pennsylvania Railroad, and of three 6000-hp steam-turbine electric locomotives now under construction for the Chesapeake and Ohio Railway Company. These are expected to be in service in the summer of 1947. Mr. Allen predicted that an oil-burning gas-turbine locomotive will be built in about 18 months, and a coal-burning gas-turbine locomotive within the next 3 to 4 years.

The first regular meeting of the season was held in October at the Engineers Club, San Francisco, Calif. The 52 members and guests heard the story of physical-metallurgy research at the University of California. Chairman M. P. O'Brien briefly outlined the historical development at the university to show the emphasis now given to physical metallurgy and introduced the speakers, R. R. Hultgren, J. E. Dorn, and E. R. Parker, members of the staff in mining and metallurgy at the University of California.

Professor Hultgren, describing the facilities and plans for physical metallurgy at the University, said that the present laboratories are new and well equipped for both instruction and research and that approved plans for immediate expansion will soon make these facilities equal to the best in the country. Prof. J. E. Dorn presented a theory and the supporting experimental results for predicting plastic-flow behavior as required for the design of light-alloy forming operations, a University of California contribution in metallurgical war research. Professor Parker described the investigations and results obtained in the determination of important factors for brittle fracture of steel, another contribution of the University in this field as a part of the welded-ship-plate war research. He said that while brittle fracture is more likely to occur at low temperature, combined stress causes such failure at ordinary temperature. He also observed that stress concentration and character of loading, controlled by design, are most important as factors causing this type of failure in welded ship plate and that the importance of residual stress in welding has been overemphasized.

"Mechanical Shaft Seals" Talk at Southern California Section

On Oct. 17 in the Rodger Young Auditorium, Los Angeles, Cal., the members heard a talk on "Mechanical Shaft Seals," by Jack Sturgess, engineer, Union Oil Company of California. Mr. Sturgess covered the present field and discussed the adaptability of mechanical shaft seals to the requirements of the petroleum industry. His talk was well illustrated with slides showing the seals under consideration. Seventy eight were in the audience.

South Texas Section Makes Inspection Tour

The meeting on Oct. 15 was a combination inspection-exposition of an existing unit and a new unit being erected at the plant of the Houston Light and Power Company. The speaker was Harry G. Hiebeler, member A.S.M.E., assistant superintendent, power, Houston Light and Power Company, who described in detail the boilers, burners, turbines, auxiliaries, building, provisions for servicing and operation, and operators' duties. The talk was entitled "Modern Steam Power-Plant Design and Operation." Thirty-five members and ten guests inspected the unit.

Joint Meeting of Syracuse Section and N.S.P.E.

A dinner meeting was held with the Syracuse Section of the National Society of Pro-

MEMBERS OF THE CINCINNATI AND WEST VIRGINIA SECTIONS DURING AN INSPECTION VISIT TO THE CARBIDE AND CARBON CHEMICALS CORPORATION, INSTITUTE, W. VA.

fessional Engineers, on Oct. 14 at the Technology Club, Syracuse, N. Y. William F. Ryan, fellow A.S.M.E., Stone and Webster Engineering Corporation, and a national director of the National Society of Professional Engineers, gave a talk on "Is Engineering a Trade or a Profession?" He compared the complicated organization chart of engineering societies with the clean-cut American Medical Association chart and suggested membership in the National Society of Professional Engineers as a universal rallying point for the profession. Two hundred and ten were in the audience.

Toledo Section Has Two October Meetings

On Oct. 15 in the Doermann Theatre, University of Toledo, Toledo, Ohio, Dr. H. B. Osborn, Jr., research engineer, Ohio Crankshaft Company, gave a talk entitled, "What's New in Industry?" The speaker was very interesting, and his talk was illustrated with slides showing new and old machine tools and how one machine does operations formerly requiring three or more machines. This was a Toledo Technical Council meeting sponsored by the American Welding Society.

A joint A.S.M.E.-A.I.E.E. meeting was held in the Doermann Theatre on Oct. 21, to hear Dr. Phillips Thomas, Westinghouse Research Laboratory, speak on "Adventures in Research." As several evening classes at the University of Toledo were excused from class that they might attend the program, the audience totaled 750. Dr. Thomas used simple demonstrations to show radio progress from long wave to ultra short wave. Radar was also demonstrated in an elementary way. Two moving pictures were shown, the first, "Dawn of Better Living," and the second, "Summer Storm."

"Human Engineering" Topic at Waterbury Section

On Oct. 22 in the University Club, Waterbury, Conn., Myron H. Clark, management consultant, gave a talk entitled "Human Engineering." Mr. Clark pointed out that the engineer's technical knowledge had advanced much more than his "know how" of handling men, and that industry as a whole must give supervisory employees better training if progress is to continue. Attempts to train labor before management is thoroughly conditioned will result in indigestion, the speaker said. Thirty eight were in the audience.

"Soviet Foreign Policy" Talk at Western Washington Section

"Soviet Foreign Policy in the Far East" was the subject at the Oct. 2 meeting in the Engineers Club, Seattle, Wash. Dr. Ivar Spector, associate professor of Russian in the University of Washington, gave a lecture which provided much food for thought on the Russian situation. He had served in the Russian army in World War I and was therefore qualified to speak on the subject. He held out much hope for peace with Russia if we learn to know the Russian's thought and soul. Sixty one attended.

West Virginia—Cincinnati Sections Have Exchange Meeting

Forty members of the Cincinnati and West Virginia Sections inaugurated the first of two exchange meetings on Oct. 18, with a luncheon at the Daniel Boone Hotel, Charleston, W. Va. After luncheon, 55 members left to visit the largest unified synthetic-rubber installation in this country at Institute, W. Va. The inspection trip covered both the Butadiene and styrene plants of the Carbide and Carbon Chemicals Corporation, and the copolymer plant of the United States Rubber Company. That same evening at a dinner in the Daniel Boone Hotel, a certificate commemorating his many years of service for the West Virginia Section was presented to past-chairman F. Leroy Schaefer, now a member of the Cincinnati Section. A lecture followed entitled "Gas Turbines for Process Industries," by Paul R. Sidler, member A.S.M.E., president, Brown, Boveri Corporation, New York, N. Y. Mr. Sidler's talk was distinguished by an orderly review of the many kinds of applications of gas turbines, presented in a stimulating manner, with all the force of his engaging personality. Ninety were in the audience.

Student Branches

University of Akron Branch

The first meeting of the new term was held on Oct. 22 for the purpose of electing officers. Prof. Fred S. Griffin, member A.S.M.E., honorary chairman, occupied the chair until the election of officers was completed. Results of the election were as follows: James E. Masters, chairman; William A. Green, vice-chairman; Robert O. Foster, secretary, Joseph A. Pappano, treasurer, and Prof. F. S. Griffin, honorary chairman.

Polytechnic Institute of Brooklyn (Day) Branch

Chairman Dominick Casale opened the first meeting of the new season on Oct. 15, welcoming both old and new members. The new officers were introduced: Prof. George E. Petersen, junior member A.S.M.E., honorary chairman; Dominick Casale, chairman; Frank Raffa, treasurer, and Arthur Lotz, secretary. Raymond Flynn was elected as vice-chairman, as Richard Foxen who held that position had been drafted. Professor Petersen outlined the program for the coming season and encouraged one and all to become active in the branch. He then introduced the new head of the mechanical-engineering department, Prof. Ernest L. Midgette, junior member A.S.M.E., who gave a short talk. Thirty-two members paid their registration fees for the year at this meeting.

Carnegie Institute of Technology Branch

At the opening of the fall semester the branch was without officers, but after the honorary chairman had organized the branch and conducted a membership drive, election of officers was held, with the following results: A. J. Sullivan, president; J. L. Jackson, vice-president; D. W. Watt, secretary-treasurer.

University of California Branch

The meeting on Oct. 9, in room 9, Engineering Building, was opened by Harry Lucheta, chairman, who read the names of the members on the various committees, outlined the duties of the committees, and suggested that they meet and select a leader to serve on the executive committee. The resignation of R. Gordon Reeder, treasurer, was accepted, and a new treasurer elected. The officers for the coming year are: Harry Lucheta, chairman; Albert Strong, vice-chairman; Bill Gray and Frank Martin, secretaries, and Ira Nagin, treasurer. The honorary chairman is H. A. Johnson, junior member A.S.M.E., assistant professor of mechanical engineering. Applications and fees were accepted from new members.

The Catholic University of America Branch

The first meeting of the new season was held on Oct. 15 in the mechanical-engineering department. Application forms and renewal cards were distributed to prospective members. Twelve renewal cards were signed and twelve new students made application for membership. Mr. Weschler, head of the department of mechanical engineering, gave a talk on the aims and purposes of the A.S.M.E. and the value of student membership to mechanical-engineering students. Committees were appointed as follows: Program Committee, Nicholas S. Lizzo, Daniel F. Mangin, and James E. Shea; Membership Committee, James F. Clement and Harry M. Peden; Refreshment Committee, Vincent T. O'Brien, Edward J. Michuda, and Frank E. Dorsey.

University of Cincinnati Branch

A joint meeting with the A.S.M.E. Cincinnati Section was held on Oct. 10 in the auditorium of the Engineering Societies Building, Cincinnati, Ohio. Fifteen members of the branch, accompanied by Professors Bunting and Smith, enjoyed the interesting talk by Mr. Hoffman of Chicago, on the heat-treating of gears by induction methods.

H. B. Welge, secretary, A.S.M.E. Cincinnati Section, welcomed the representatives of the branch and invited the members to attend any of the future meetings of the Section which may be of interest to the students.

College of the City of New York Branch

The branch met on Oct. 10 in Compton Hall Museum, to hear Charles Fay of the Bell Aircraft Company lecture on jet-propelled aircraft. The history of the "XP59," the Bell "Comet," in its experimental stages, was traced in a technicolor film that carried it from the first British and American sketches to its final performance as the "P59" in the closing battles of World War II. Mr. Fay noted that the principle of jet propulsion, Newton's second law of action and reaction, was not new. Hero, the Roman, used it in what was one of the first engines utilizing the turbine principle. Moreover, the speaker said, the potential usefulness of the jet-propelled engine need not be restricted to aircraft alone but may be expanded to include many forms of transportation and power where high efficiency at high speeds and high altitudes and its principle of continuous burning can be used to advantage. The 75 members present joined in the question-and-answer period following the talk. A film demonstrating the remarkable capabilities of the Bell helicopter was shown, which included the "hands-off" control and landing and safe descent despite complete engine cutoff.

Colorado A.&M. College Branch

The first meeting of the new school year was held on Oct. 7 in the Mechanical-Engineering Building, with 19 members present. After a talk on the benefits to be derived from membership in the A.S.M.E. student branch, 9 new members filled out application blanks for membership, and 8 old members renewed their memberships. The guest speaker of the evening was Prof. H. B. Mummert who gave an interesting talk on recent developments of the gas turbine.

At the meeting on Oct. 21 in the Mechanical-Engineering Building, the 23 members present enjoyed pictures on the "Steam Turbine" and "When You Can Measure," both supplied by the General Electric Company.

Cornell Student Branch

The opening meeting of the new school year was held on Oct. 23 in Sibley Hall. Dean Hollister, member A.S.M.E., dean of engineering, spoke briefly to the members. Prof. W. J. King, member A.S.M.E., new director of mechanical engineering, gave an interesting talk on "Trends in Mechanical Engineering," in which he described briefly what is new on the frontiers of engineering today. The certificate of merit, awarded to one student each year, was presented by Professor King to Jarman G. Kennard. One hundred and fifteen were at the meeting.

At the Oct. 30 meeting Mr. Partington of the American Locomotive Company, spoke on "Welding as Applied to Locomotives," illustrated with slides. Eighty one were present.

Drexel Institute of Technology Branch

The first meeting of the fall term was held on Sept. 26 in the Student Union building. The meeting was called to order by John Herman, chairman, who gave a short talk on the value of joining the A.S.M.E. The new honorary chairman of the branch, Prof. Dawson Dowell, member A.S.M.E., was then introduced. Professor Dowell gave a short and inspiring talk on the history of the branch at Drexel and stressed the need of co-operation in order to have the branch back on a sound, peacetime basis and of more benefit to students. The topics of various papers were given to the students, with the list of awards available to the winners.

Duke University Branch

The first meeting of the new school year was held on Oct. 22 when the new officers were introduced: Clifford L. Sayre, president; E. Wilson Griffin, vice-president; Edward M. Linker, treasurer; James T. Reynolds, secretary. The president gave a brief outline of the schedule for the coming year and asked that renewal cards and new membership blanks be made out and handed in at the first possible date. Professor Reed, member A.S.M.E., student adviser, asked for a good showing at the Raleigh meeting. He urged earlier and larger memberships. The president introduced F. Dieter, Durham's city engineer, who gave a talk entitled, "The City as a Machine for Living." Mr. Dieter discussed the development of city planning from the beginning of the nineteen hundreds up to the present, commenting on a few of the many factors which must be considered in the planning of an efficient city.

University of Florida Branch

On Oct. 25 a meeting was called to order by John Carpenter, chairman. Mr. Hines discussed the proposed the Engineers' Fair which is to be put on by the students of the engineering college in an effort to publicize the industrial advancement of the State of Florida and the University of Florida College of Engineering. The A.S.M.E. went on record as favoring the latter part of February or early part of March as the best time. Professor Ebaugh, member A.S.M.E., announced that there would be a joint dinner meeting of the branch and the A.S.M.E. Florida Section on Nov. 4 at the Hotel Thomas in Gainesville.

Iowa State College Branch

A smoker was held on Oct. 10 in room 206, Memorial Union. The program consisted of two films, one entitled "Flame and Sand," and the other a cartoon. After the showing of the films, Richard Dove, chairman, introduced Prof. Henry Black, member A.S.M.E., head of the mechanical-engineering department, who in turn introduced all the faculty members who were present. Professor Cleghorn, member A.S.M.E., gave a short talk on the activities of the A.S.M.E. Thirty students made application for membership. Election of officers followed: Honorary chairman, Prof. Robert W. Breckenridge, associate member A.S.M.E.; president, Richard C. Dove; vice-president, Robert H. Burgan; treasurer, Don R. Meier; secretary, Floyd J. Stanek.

The Oct. 31 meeting in the Engineering Assembly, Engineering Hall, was called to order by Richard Dove, president. He introduced Robert Burgan, vice-president and program chairman. Mr. Burgan then introduced E. E. Anderson, representative of E. I. du Pont de Nemours and Company, who gave an interesting and educational talk entitled "Color Conditioning," illustrated with a film. One hundred and twenty were present.

University of Iowa Branch

At the Oct. 15 meeting in Studio D, Radio Building, the guest speaker was Mr. Milbrook, assistant engineer of the Standard Oil Company. He gave an informal talk on some of the bottlenecks with which the Standard Oil Company has been confronted in the construction and processes in the new cracking plant and power plant. A discussion period was held at the end of the talk.

University of Kentucky Branch

On Oct. 25 election of officers for the coming year was held in the engineering study hall. The following were elected: C. E. Youngblood, chairman; William C. Caywood, vice-chairman; H. J. Macke, secretary; Walter W. Aton, treasurer. A unanimous vote of thanks was given to Miss Jeannette Reynolds, retiring chairman, for her work in the organization.

On Nov. 1 a brief business meeting was held in room 201, Pence Hall. Dr. Webb, of the department of physics, was introduced and gave a timely and stirring talk on the subject of atomic energy from the point of view of the physicist. He traced briefly the history of how man has continually sought better ways to do the work of the world, and he said that the development of atomic energy was an outgrowth of that trend. He felt that the world was coming into a new era in engineering and expressed his strong belief that atomic energy would be used as a source of power in the near future. The program was one of the best the branch has ever had.

Marquette University Branch

On Oct. 3 a meeting was held in the Engineering Building. William Pautke, president, gave a brief review of the past activities of the A.S.M.E. at Marquette and outlined the organization's tentative plans for the future. Because most of the students present were unfamiliar with the A.S.M.E., the president gave a thorough description of both the national and local organizations, the advantages of being a member, the dues, and the magazine MECHANICAL ENGINEERING. The treasurer, Les Randall, gave a report on the present state of the treasury. Forty five were present.

Forty were present at the meeting on Oct. 24. Membership blanks were on hand and all present joined the organization. Six previous members renewed their membership, 14 seniors joined the national organization as student members, and the rest of the students present, being underclassmen, joined the local organization.

University of Maryland Branch

A short business meeting was held on Oct. 9 when plans were discussed for future meetings.

On Oct. 23 in the Administration Building, Willy Ley spoke to the members on the development of the "Liquid Fuel Rocket." Mr. Ley was one of the original members of the German Rocket Society in 1929. When Hitler came into power and dissolved the society, Mr. Ley came to America where he has since been prominent in rocket research. He dis-

cussed the history of rockets with special emphasis on the V-2 rocket and predicted that in the immediate future most rocket improvement will be in improving exhaust design so as to more closely approach the exhaust velocities theoretically possible. At present only about 50 per cent of the theoretical velocity has been reached in practice. Edward Talone, student president, presented the "Man-Miles Cup" to the branch. This cup was won by the branch at the Bucknell University Convention last spring. A group of 150 members and guests, including several prominent engineers, were present.

Massachusetts Institute of Technology Branch

The first business meeting of the fall term was held on Oct. 3 in room 3-270. Chairman Bernard Morrill and secretary-treasurer Ben Ranan reported on the summer activities. Election of officers was held, with the following results for the academic year 1946-1947: Richard F. Miaskiewicz, chairman; George Richard Turner, vice-chairman; Edward Hawks O'Brien, secretary-treasurer. It was decided to start a membership drive immediately.

On Oct. 23 Richard F. Miaskiewicz, chairman, spoke briefly on donating money to the Salvation Army on behalf of the Greater Boston Appeal. He then introduced Prof. H. E. Edgerton of the M.I.T. electrical-engineering department, who gave a talk entitled "Applications of the Stroboscope in High-Speed Photography." Professor Edgerton, one of the pioneers in this country in the development of high-speed photography, explained the workings of a strobotachometer, using a set of amusing stroboscopic disks, one of which appeared to have a series of small balls being juggled around circles on the periphery of the disk. He then showed a silent motion picture made by him at M-G-M studio in California during the war. This picture showed what actually took place when a cat drank milk, when a soap bubble was pierced by a pencil, when an electric-light bulb is shot at by an air rifle. The picture also showed the take-offs of various birds and insects. The picture concluded with smoke vortices being churned up by fan blades. The talk was both amusing and interesting. Ninety five were present.

Michigan College of Mining and Technology Branch

On Oct. 29 a meeting was held in the clubhouse. Chairman Delavin Young presided. Various committee heads were introduced and volunteers were called to round out the committees. A membership committee under Todd Webb outlined plans for student participation in A.S.M.E. Each member present introduced himself or herself and gave a brief history of his or her life.

Mississippi State College Branch

Officers elected at the Sept. 24 meeting in room 106, Engineering Building, were: J. O. Stephens, chairman; C. D. Moore, secretary; J. W. Gardner, treasurer; R. T. Staton, Jr., junior member A.S.M.E., honorary chairman.

The Oct. 3 meeting in room 106, Engineering Building, was held to discuss plans for a banquet in honor of E. E. Williams, vice-president, A.S.M.E. Region IV, to be held in the College Grill on Oct. 8. Fred O'Kelly was elected vice-chairman.

On Oct. 8 a banquet was held in the College Grill in honor of E. E. Williams, vice-president, A.S.M.E. Region IV. All members were invited and 39 members and 17 guests were in attendance. Mr. Williams gave a very interesting talk on the organization of the A.S.M.E., the function of the Society, and some of the advantages derived from membership in it.

A short meeting was called on Oct. 16 to discuss plans for representation in the college annual. It was decided that two pages be used for representation of the branch and paid for by assessment of each member.

Missouri School of Mines and Metallurgy Branch

The first meeting of the new term was held on Oct. 9, when 180 mechanical-engineering students enjoyed open house. The business session was conducted by E. A. Henke, chairman. The other officers are: C. Kaplan, vice-chairman; E. Lindquist, secretary; and L. Wilson, treasurer. The chairman introduced the honorary chairman, Dr. A. Miles, member A.S.M.E., head of the mechanical-engineering department. Dr. Miles, in turn, introduced faculty members of the mechanical-engineering department to the students. Professor Boyer, also of the mechanical-engineering department, showed technicolor slide pictures, depicting the landscape and waterways surrounding our Alaskan possessions, featuring hydroelectric investigations. At the close of the meeting 30 mechanical engineering students joined the branch.

Montana State College Branch

On Oct. 9 a meeting was held in room 218, Roberts Hall, for the purpose of electing officers for the new term. Those elected were: Robert Anspach, chairman; George Oiye, vice-chairman; Robert Adams, secretary; Robert Oertli, treasurer. Prof. Chester A. Arents, member A.S.M.E., was unanimously elected honorary chairman.

The meeting on Oct. 21 featured a movie on the Boeing Stratocruiser. Professor Zilka, who was formerly employed by Boeing Aircraft, gave an interesting talk on the airplane.

University of Minnesota Branch

Seventy-three new members and 11 renewals joined the branch at the first meeting of the fall quarter, on Oct. 9 in Coffman Memorial Union. Chairman Louis Mrachek gave a brief speech on the objects of A.S.M.E. for new members and visitors. Prof. Frank Rowley, member A.S.M.E., head of the mechanical-engineering department, gave a speech of welcome and introduced members of the mechanical-engineering faculty. Other speakers were Prof. A. O. Lee, junior member A.S.M.E., faculty adviser of the branch, and Arnold L. Ender, student member, who discussed the annual convention of the Mid West branches of A.S.M.E. Two movie shorts were shown.

On Oct. 23 Ramendra Banerjee, graduate of Calcutta University, and now a graduate student in mechanical engineering at the University of Minnesota, spoke on "Engineering in India." Publicity, program, entertainment, and technical committees were named by Frank Monroe, vice-chairman.

MISSISSIPPI STATE COLLEGE STUDENT BRANCH AT A MEETING HELD IN HONOR OF E. E. WILLIAMS, VICE-PRESIDENT, A.S.M.E. REGION IV

University of New Hampshire Branch

The first meeting of the new season was held in Conant Hall on Oct. 16. Forty nine were present. A new vice-chairman, Arthur Clement, was elected to replace the vice-chairman-elect who has left the university. Registration cards were filled out, and the purpose and aims of the Society were pointed out by the adviser, Mr. Kauppinen, junior member A.S.M.E. Plans were discussed for future meetings, and a program committee appointed for the next meeting.

On Oct. 30 a meeting was held in Murkland Hall. Dues for the year were collected to be sent in for pins and magazines. An interesting movie was shown depicting the construction of the Golden Gate Bridge.

New York University (Day School) Branch

The largest number ever assembled by the branch, totaling 185, attended a smoker on Oct. 14 in Lawrence House, to hear Prof. H. J. Brenneke, junior member A.S.M.E., whose topic for the evening was "Planning Your Career." The talk was a timely and interesting one and enjoyed by the members. Prof. Ferdinand Singer, member A.S.M.E., welcomed new members and praised the organization for having one of the largest active memberships in the country. Announcement was made of a paper contest for prizes.

New York University (Evening School) Branch

The new semester was opened with a meeting on Oct. 15 in room 1170, Waverly Building, Washington Square. The chairman, W. L. Byler, greeted the many new members and introduced the speaker, R. F. Gagg, vice-president, A.S.M.E. Region II, and assistant to the general manager, Wright Aeronautical Corporation, Paterson, N. J. Mr. Gagg spoke on the organization of the A.S.M.E., and the many things it does to benefit industry, engineers as a group and as individuals, as well as engineering students. A sound film followed, entitled "Progress Through Engineering," shown through the courtesy of the General Motors Company. Prof. A. H. Church, member A.S.M.E., honorary chairman, of the machine-design department, gave a brief talk, in which he pointed out that the wide spread of A.S.M.E. activities makes it possible for a mechanical engineer to benefit from membership in the Society, regardless of the branch of engineering he is in, while most societies, being of a specialized nature, do not offer a similar opportunity.

Northeastern University Branch

The first meeting of the new school year was held in Richards Hall on Sept. 23. John McManus, program chairman, gave an outline of possible events for the coming season. Prof. F. A. Stearns, member A.S.M.E., gave a short talk on possible attainments of the branch the coming year and urged attendance at the A.S.M.E. Fall Meeting at the Hotel Statler. Prof. J. W. Zeller, member A.S.M.E., head of the mechanical-engineering department, excused the seniors from classes on Oct. 1, to attend the General Electric field trip with A.S.M.E. convention members.

On Oct. 1 a party of 38 seniors visited the General Electric plant, with other members of A.S.M.E. They saw the steam-turbine division, the main power plant, and the aircraft gas-turbine exhibit. In the evening 42 members of the branch were present at the Statler Hotel where they heard Eugene W. O'Brien, presidential nominee, A.S.M.E., speak on "Places to Go and Things to Do."

The Oct. 23 meeting, held in the Student Union, introduced Joseph S. Alford, aircraft gas-turbine division, General Electric Company, Lynn, Mass., who gave a brief history of gas turbines and operating characteristics of conventional, compound, turbine-driven propeller, and jet aircraft engines. Slides showing direct comparison of these types of engines accompanied the lecture. A colored moving picture of jet aircraft in action, principally the Lockheed P-80 "Shooting Star" powered by a G.E. I-40 jet engine. A lively discussion period followed. The audience numbered 103 members and 4 guests.

Ohio State University Branch

At the meeting on Oct. 17 in Robinson Laboratory, Prof. F. W. Marquis, member A.S.M.E., introduced Prof. E. J. Lindahl, member A.S.M.E., the new faculty adviser. Prof. S. R. Beitler, vice-president, A.S.M.E. Region V, discussed "The Advantages of A.S.M.E. Membership." His talk made such an impression that over 70 applications for membership were received at its close. Professor Dumble gave a brief talk on "Things-to-Come on the Campus," with special emphasis on the coming activities of engineers.

Oklahoma A.&M. College Branch

A reorganization meeting was held on Oct. 28 in Engineering 201. The guest speaker was Harry Pearson, a member of the A.S.M.E. Committee on Relations With Colleges. His subject was "Why I Want to Be a Member of Such a Professional Society as the A.S.M.E." Forty-three applications for membership were received, and plans for the first meeting were made. E. C. Isbell, a former student chairman, was in charge of the meeting which was a smoker.

Oregon State College Branch

Invitations were extended to other engineering societies to attend the opening meeting of the branch on Oct. 17. The program featured Howard G. Vesper, president of the California Research Corporation, who covered the following subjects before an audience of 150 students: (1) Opportunities in the field for graduates of mechanical engineering, including plans for advancement; (2) type of work, design, testing, or trouble-shooting, and specialized knowledge required; (3) qualities of young men which are most desirable in that organization; (4) location of major engineering staffs for that particular firm; (5) plans for expansion in the West.

Purdue University Branch

The first meeting of the season was held on Oct. 22 in the Electrical Engineering Building. Before the meeting, the officers gave a dinner to the guest speaker in Student Union. Professor Zucrow, of the mechanical- and aeronautical engineering schools at Purdue, gave a talk entitled "Jet Propulsion" before an audience of 350 students and faculty members. He covered this new field lucidly and his subject was presented so as to reach the student as well as the professional man.

Pratt Institute Branch

The first meeting of the new season was held on Oct. 1, at which time many new members joined the branch. The following officers were elected for the coming year: John Stephen, chairman; Stanley Labeki, vice-chairman; Frank J. Smollon, Jr., secretary; and Emile S. Wuertz, treasurer. Pleasure was expressed in the appointment of Prof. W. B. Moen, junior member A.S.M.E., as honorary chairman. A committee was named for the purpose of organizing programs for future meetings. One of the topics discussed was the presentation of a paper by a Pratt student at a regional meeting in the near future.

Princeton University Branch

The first meeting of the new term was held on Oct. 8 in the lounge of the Engineering Building, for the purpose of reorganizing. Former members were welcomed back, and members-to-be made out their applications. Kenneth H. Condit, member A.S.M.E., dean of engineering, told the students of the advantages to be derived from membership, and of the work done by the A.S.M.E. on behalf of the engineering profession. Election of officers was held, with the following results: George W. Shepherd, Jr., junior member A.S.M.E., assistant professor of mechanical engineering, was elected honorary chairman; Kenneth Steinhardt, chairman; Stewart Stringfellow, vice-chairman; Charles Scheuerman, secretary-treasurer. Two moving pictures were shown, one entitled, "The Worthington Hydro-Barker," which showed how bark is removed by hydraulic pressure with a minimum of usable wood lost; and the second "The AT-21," which explained how Fairchild constructs its plastic plane.

South Dakota State College Branch

The first meeting of the new term was held on Oct. 3 in the Engineering Building, with 48 students present. Chairman Eugene Case centered the discussion about A.S.M.E. membership and home-coming activities. Prof. Lee L. Amidon, member A.S.M.E., gave a brief résumé of A.S.M.E. interest in engineering students and was followed by secretary of the branch, Nelsen, who, after giving a brief talk on the advantages to students in the A.S.M.E., signed up 18 members. The following were appointed: James Trenerry, chairman of meetings and papers committee; Thomas Cruisinberry, chairman of membership committee; Ralph Peterson, chairman of publicity committee.

University of Southern California Branch

On Oct. 3 at a meeting held in room 205, Administration Building, scheduled plans for the coming semester were outlined, and suggestions solicited from the members. Prof. E. K. Springer, member A.S.M.E., explained the procedure in writing competition engineering papers; a committee for publicity

and the expediting of functions was formed; and questions about the student branch answered. The guest, Mr. Blaich, gave a short talk on re-enlisting ex-Navy men to a reserve status in preparation for an "emergency." Henry A. Hoste, chairman, was in charge of the meeting.

Southern Methodist University Branch

At a special meeting on Oct. 18, new officers were elected as follows: Clarence Eaton, chairman; Irving Goldgar, vice-chairman; Blake Brown, secretary; Frank McGowan, treasurer, and Tom Herndon, sergeant-at-arms and parliamentarian. The new chairman then appointed the membership, program, social, and transportation committees. These committees are making plans for meetings, socials, and field trips.

University of Tennessee Branch

The first meeting of the new term on Oct. 9 was attended by 48. Prof. R. L. Maxwell, formerly with the Case School of Applied Science and the M.A.C.A. Laboratories of Cleveland, spoke on "Jet Propulsion and Robots." Officers and representatives elected were: J. C. Maxwell, chairman; Ralph Gluck, vice-chairman; H. E. Smalling, secretary-treasurer; Roscoe W. Morton, honorary chairman; A.C.E. board representatives: J. C. Maxwell, R. H. Grass, and R. M. Farnham. Prof. R. W. Morton, member A.S.M.E., discussed student membership, and a membership drive was started. The chairman appointed C. A. Snyder and R. M. Farnham as program committee for the next meeting.

The second meeting was held on Oct. 24 in Estabrook Hall. The guest speaker was William R. Chambers, fellow A.S.M.E., who is associated with the Tennessee Eastman Corporation at Oak Ridge, Tenn. Mr. Chambers gave a talk entitled "Mechanical Engineers' Responsibility in the Atomic Age." Chairman J. C. Maxwell appointed Sherman Hixon and Ralph Gluck on the program committee for the meeting on Nov. 7 and Robert Grass and Paul Isabell on the program committee for the meeting on Nov. 21.

University of Texas Branch

On Oct. 21 a meeting was held in the Mechanical-Engineering Building when V. L. Doughtie, member A.S.M.E., the new honorary chairman, was introduced. Plans were made to sponsor an A.S.M.E. athletic program in the Engineering Society League which is being revived this year.

Texas A.&M. College Branch

A general meeting was held on Oct. 15 in the Mechanical Engineering Building. Plans of the present membership drive were discussed. It was decided that booths would be placed at convenient locations to aid those desiring membership. Results of the drive have so far increased the membership to 230. The guest speaker, W. R. Horsley, director of the Student Placement Office, discussed the relation of his office not only to the graduating senior, but to the other students as well. An open discussion followed the lecture.

Tufts College Branch

The first meeting of the new semester was held on Oct. 14, with James McNeil, the president, presiding. The new officers were introduced: James McNeil, president; Richard Daniels, vice-president; Donald W. Kitchin, Jr., secretary; Prof. D. A. Fisher, junior member A.S.M.E., honorary chairman. Registration of 37 old and new members was taken. President McNeil spoke briefly on the objectives of the branch for the year and requested volunteers to serve on the program, publicity, and membership committees. Professor Fisher gave an interesting talk on coming activities.

On Oct. 22 a second meeting was held. Prof. T. K. Sherwood, dean of engineering at Massachusetts Institute of Technology, gave a fascinating talk on the past history, the present stages of development, and possible future implications of atomic energy, describing many of the enormous problems that had to be solved in its development, as well as the basic principles of atomic physics. The subject matter was presented in a clear, understandable manner. The talk ended with an optimistic prediction that atomic energy will be used constructively for the betterment of civilization and a new age of scientific marvels. Professor Sherwood then held a brief discussion period. So great was the interest aroused that it became necessary for the chairman to terminate the question period which had continued to a late hour. Several new members joined the branch.

University of Vermont Branch

On Oct. 16 a meeting of mechanical-engineering students was held in the Waterman Building. I. T. Hook, research engineer for the American Brass Company, delivered an address, illustrated with a film, entitled, "Open-Pit Copper Mining in Chile." Mr. Hook exhibited several samples of copper alloys and explained the chemical properties and uses of them. Professor Chapman, member A.S.M.E., honorary chairman of the branch, explained the organization briefly. It was decided to organize a branch of A.S.M.E. The following officers were elected: George Ruble, president; Malcolm Eddy, vice-president; Wendy Millington, secretary; Marion Nelson, treasurer.

Villanova College Branch

The opening meeting of the term was held on Oct. 25, for the purpose of organization which included the appointment of committees to facilitate the student officers in their efforts to prepare interesting meetings. J. S. Morehouse, member A.S.M.E., dean of engineering, gave a short talk on the advantages of A.S.M.E. membership and the benefits derived from it. He also gave some valuable suggestions on conducting an interesting and profitable meeting. Twenty two were present. James Murphy presided.

University of Washington Branch

The first meeting of the fall quarter was held on Oct. 8 in Guggenheim Hall. Kenneth Decker, chairman, introduced the first guest speaker, S. LeRoy Crawshaw. Mr. Crawshaw, manager of engineering and sales, Western Gear Company, and vice-chairman of the Western Washington Section, A.S.M.E., spoke on the opportunities offered by A.S.M.E. to the college student; he urged every member to participate in all activities sponsored by joint meetings, as well as those scheduled by the branch. The second guest speaker, Ray A. Thompson, junior member A.S.M.E., West-

THE STUDENT BRANCH OF THE UNIVERSITY OF TEXAS, AUSTIN, TEXAS

inghouse engineer, and chairman of Student Relations Committee, Western Washington Branch, explained the functions of his committee. Richard W. Crain, Sr., junior member A.S.M.E., honorary chairman, gave a brief résumé of benefits derived from the organization. After the program, each member filled out a questionnaire similar to the survey outlined on page 14 of the "Operation Manual." Applications for new membership totaled 52, and for renewal of old memberships, 20.

Washington State College Branch

The traditional "Cider Bust" was held on Oct. 16 in room 110, Mechanical Arts Building. Chairman Pat O'Neil introduced the officers of the branch, and a short talk was given by Prof. F. W. Candee, member A.S.M.E., honorary chairman, who stressed the advantages both now and in the future of being a member of A.S.M.E. Dean R. D. Sloan welcomed the many new and old members who were present. Dr. Pearl, head of the department of mechanical engineering, introduced Professors Chase, Sayles, Johnson, Thornton, and Dr. Fried, and faculty assistant Tom Robinson, who were the faculty members present. Dr. Pearl, who has recently been affiliated with the Whiting Corporation, Chicago, Ill., gave an interesting talk on the value of engineering and other technical societies to industry and urged the students to avail themselves of the benefits of A.S.M.E.

At the Oct. 31 meeting Dr. Pearl, head of the department of mechanical engineering, gave a very interesting talk on the engineering aspects of industry and related many of his experiences when he was chief engineer for the Whiting Corporation of Chicago. He urged all students to concentrate on getting a good background in the basic principles of engineering while in school and make no strenuous attempt to specialize until later. Specialists, he said, need to know the fundamentals of general engineering.

Worcester Polytechnic Institute Branch

Election of officers was held on Oct. 8, as follows: John H. Williams, president; Lawrence T. Garnett, vice-president; Sidney B. Wetherhead, secretary-treasurer.

Meetings and Expositions of Other Societies

A.A.A. Science

THE American Association for the Advancement of Management will hold its annual meeting in Boston, Mass., Dec. 26 to 31, 1946. Section "M," Engineering, of the A.A.A.S. will present its program on Saturday, Dec. 28, and Monday, Dec. 30. Eleven papers will be presented at four sessions.

Materials-Handling Problems

The first exposition to deal entirely with industry's materials-handling problem, a phase of industry which represents approximately one quarter of all costs, will be held at the Public Auditorium, Cleveland, Ohio, Jan. 14 to 17, 1947.

Electrical Engineering

The 1947 Electrical Engineering Exposition will be held in the 71st Regiment Armory, New York, N. Y., Jan. 27 to 31, 1947. The exposition will be held concurrently with the Winter Convention of the American Institute of Electrical Engineers.

A.S.T.M.

The spring meeting of the American Society for Testing Materials will be held at the Benjamin Franklin Hotel, Philadelphia, Pa., Feb. 24 to 28, 1947.

A.S.M.E. Sections

Coming Meetings

Chicago: December 5. The Junior Division of the Chicago Section is sponsoring an inspection tour through the Fiske Street Station of the Commonwealth Edison Company.

December 12. The Product Design Division of the Chicago Section is sponsoring a meeting on the subject of "The Design of Bearings."

Detroit: December 3. Horace H. Rackham Education Memorial, Detroit, Mich. The Materials Handling Division is sponsoring a meeting; subject and speaker have not been announced.

Ithaca: December 16. Arlington Hotel, Binghamton, N. Y., at 8:00 p.m. Dinner at 6:30 p.m.; meeting at 8:00 p.m. Subject: "The Program and Philosophy of the New York State Institute of Applied Arts and Sciences at Binghamton," by C. C. Tyrrell, director, New York State Institute of Applied Arts and Sciences.

Metropolitan: December 10. Room 501, Engineering Societies Building at 7:30 p.m. Speaker: Elliott A. Evans, chief chemist, C. C. Wakefield and Company, Limited, London England. Subject: Development, Manufacture, and Application of Lubricants.

Philadelphia: December 10. Engineers' Club, 1317 Spruce St., Philadelphia, Pa., at 8:00 p.m.

December 17. Engineering Building, University of Pennsylvania, Phila., Pa., at 8:00 p.m. Subject: "Precision Casting," by N. L. Mochel.

Susquehanna: December 9. Joint Meeting sponsored by the Engineering Society of York.

R. E. Gibbs Named Dean of Engineering at Bradley U.

RUSSELL E. GIBBS, member A.S.M.E., has been appointed dean of the engineering division of Bradley University, Peoria, Ill. Mr. Gibbs was formerly head of the mechanical- and aeronautical-engineering departments at Montana State college, Bozeman, Mont.

U. S. Navy Accepting Applications for Civil Engineer Corps

THE Navy Department has announced that applications are now being accepted for commissions in the rank of Lieutenant (Junior Grade) in the Civil Engineer Corps of the U. S. Navy. This program is designed for engineers who intend to make the Civil Engineer Corps of the Navy their career.

In order to qualify for appointment under the above program candidates must possess the following qualifications:

(a) Be a graduate of an accredited college or university with a scientific degree in engineering.

(b) Be not less than 22 nor more than 30 years of age.

(c) Be a native-born or naturalized male citizen of the United States for at least 10 years. For those former service personnel who have had active wartime service consideration may be given to a waiver of the 10-year requirement.

(d) Have had 3 years' professional experience in engineering *or related active military service* (not in a student status).

(e) Establish mental, moral, and professional fitness, as well as aptitude for the service by means of interviews, college and employment records, and written professional examinations.

(f) Be physically qualified by standards set forth for officers of the Staff Corps, U. S. Navy. Basic physical qualifications are as follows: (1) Minimum vision in each eye of 8/20 unaided by glasses and correctible to 20/20; (2) minimum height 66 inches, maximum 76 inches; (3) weight in proportion to height; (4) normal color perception; (5) normal hearing; (6) a minimum of 20 serviceable vital teeth of which four shall be opposing molars and four opposing incisors; (7) no physical deformities; (8) normal function of all vital organs.

Application forms may be obtained by writing to the Office of Naval Officer Procurement, 90 Church Street, New York 7, N. Y.

Candidates will be processed via the Office of Naval Officer Procurement and those considered acceptable will be notified to report for professional written and oral examinations on Feb. 13 and 14, 1947. None of the examinations will require special preparations as the questions will be designed to test the general engineering knowledge of the applicant. Subsequent examinations will be held at dates to be announced later for those candidates whose application files have not been completed in time to take previous examinations.

Successful candidates will be given indoctrination training at the Civil Engineer Corps Officers' School, Port Hueneme, Calif.

Appointments made in this program will carry equal rank and privilege with graduates

of the Naval Academy and appointees will be entitled to the same advancement in rank and pay as granted to Naval Academy graduates and Naval officers appointed from civilian life in other classifications.

The base pay of a Lieutenant (jg), is $200 per month. If married, the officer receives an additional $75 per month for rental allowance plus $42 per month for subsistence. An officer without dependents receives $21 per month for subsistence and a rental allowance of $60 per month when assigned a station at which government quarters are not available for his occupancy.

U. S. Patent Office Needs Examiners

THE United States Patent Office has announced that there is a great need for patent examiners in Grades P-1 and P-2, with starting salaries of $2644.80 and $3397.20 respectively.

A bachelor's degree in engineering or four year's experience in Science is required to qualify for the P-1 grade.

Further information and application blanks may be obtained from any post office or Civil Service Commission regional office.

Engineering Societies Personnel Service, Inc.

These items are from information furnished by the Engineering Societies Personnel Service, Inc., which is under the joint management of the national societies of Civil, Electrical, Mechanical, and Mining and Metallurgical Engineers. This Service is available to members and is operated on a co-operative, nonprofit basis. In applying for positions advertised by the Service, the applicant agrees, if actually placed in a position through the Service as a result of an advertisement, to pay a placement fee in accordance with the rates as listed by the Service. These rates have been established in order to maintain an efficient nonprofit personnel service and are available upon request. This also applies to registrants whose notices are placed in these columns. All replies should be addressed to the key numbers indicated and mailed to the New York office. When making application for a position include six cents in stamps for forwarding application to the employer and for returning when necessary. A weekly bulletin of engineering positions open is available to members of the co-operating societies at a subscription of $3 per quarter or $10 per annum, payable in advance.

New York	Chicago	Detroit	San Francisco
8 West 40th St.	212 West Wacker Drive	109 Farnsworth Ave.	57 Post Street

MEN AVAILABLE[1]

CHIEF ENGINEER, graduate chemical and mechanical engineer, 20 years' experience, pharmaceutical, dyestuffs, films, oil refineries, plastic, rubber, wood composition, chemical installation, apparatus, equipment, plant layout, operation, management, and charge of engineering staff. Me-120.

ENGINEER, with record of commercially successful creative thinking and invention. Doctor's degree from Cornell in chemistry and physics. Twenty years' experience in electrical, mechanical, chemical engineering. Research, development, and design. Me-121.

INDUSTRIAL ENGINEER OR ASSISTANT TO MANAGEMENT, 31, single. Graduate industrial engineer; 4 years' varied steel-mill experience in industrial engineering, production, labor relations, administration; 2 years as naval officer in expediting incoming shipments, contract termination, personnel, in ordnance plants. Location preferred, California. Me-122-468-D-1 San Francisco.

GRADUATE ENGINEER, 24 years' experience in design, operation, and testing of steam-power plants, desires position within engineering management or as executive assistant to top management. Me-123.

MECHANICAL ENGINEERING, Canadian, graduate of General Motors Institute of Technology, Flint, Mich. Three years' wage-incentive installation for consulting engineering firm, 13 years' varied administrative experience as plant superintendent and plant engineer. Building construction experience. Me-124.

RECENT GRADUATE ENGINEER, age 21; mechanical and industrial options, desires position with progressive organization, preferably with training program. Preliminary examination professional engineer New York State passed. N.Y.U. training. Me-125.

MECHANICAL ENGINEER, 29, Purdue graduate, with well-rounded experience in operations, maintenance, test, organization, cost, and personnel in large installations. Desires responsible position in executive or service engineering. Location preferred, New York or New Jersey. Me-126.

MECHANICAL ENGINEER, young, single, B.S.M.E. Purdue, good scholastic record, one and one-half years' working experience in heat transfer and machine design. Location immaterial. Willing to travel. Me-127.

MECHANICAL ENGINEER, graduate, registered; experienced in liquefied petroleum-gas sales, engineering, construction, and installation of utilization equipment. Desires position in same work, or sales representative for L.P. gas-equipment manufacturer. Location, East. Me-128.

SALES MANAGER, ASSISTANT OR SALES ENGINEER; age 44; mechanical engineer; 20 years' diversified experience selling mechanical component parts and metallurgical-test equipment to aeronautical, radio, mill foundry, machinery, marine industries. Desires position where sales, engineering, and executive ability can be advantageously applied. Location metropolitan New York or Conn. Me-129.

ENGINEERING EXECUTIVE, graduate engineer, 1913 class. Past positions, chief engineer to vice-president. Experienced designer hydraulic presses, plastic molding, die casting, automatic screw machines, all types machine tools, heavy ordnance equipment. ME-130.

POSITIONS AVAILABLE

MANAGEMENT ENGINEERS, 2, 30-40, with B.S. in industrial, mechanical, or chemical engineering, to consult on development and applicants of position evaluation. Must have actual experience in field. Must be willing to travel. Headquarters, Delaware. W-7977.

FACTORY MANAGER, to be in complete charge of large, new, modern cosmetic and proprietary factory. Some of products to be made involve high-speed bottling and packaging operations, and conveyer-belt assembly. Must have knowledge of efficient assembly, planning, and scheduling. Mid West. W-7983.

PLANT ENGINEER with basic training in mechanical engineering and with at least 3 years' experience covering actual work in design of structural-steel members, reinforced-concrete structures and foundation, piping layout and computation, power-plant work, etc. Should be competent to handle engineering computations. Should have working knowledge of large variety of commercial, mechanical, electrical, and hydraulic devices. Should have orginality and ability to suggest new ideas and accept or improve upon ideas proposed by others. Salary, $4600–$6000 year. Northern New Jersey. W-7984.

ASSOCIATE PROFESSOR in mechanical engineering to teach thermodynamics, steam power, refrigeration, etc., with related laboratory courses. Must have good educational background and experience in field required. Position starts Jan. 1, 1947. To start, $3800 for nine months, with summer-school opportunity. North Dakota. W-7995.

MECHANICAL-DESIGN ENGINEER, with 10 years' experience on development design of cameras, mechanical computers, or any small high-precision mechanical instrument. Up to $5200 year. New York, N. Y. W-8019.

PLANT ENGINEER, to directly supervise maintenance and repairs on machinery consisting of rotary kilns, crushing and grinding machinery, belt and bucket conveyers, pulverizers, rotary driers, crystallizers, locomotive cranes, 1000-hp boiler plant. $5000–$6000 year depending on ability. Northern New Jersey. W-8038.

ENGINEER, to make engineering investigation involving core making, gray-iron foundry and machine operations. Must be familiar with modern foundry equipment, methods, and plant layout; also tooling, machining, and materials handling. Pennsylvania. W-8039.

SALES ENGINEER, young, with some ex-

[1] All men listed hold some form of A.S.M.E. membership.

perience in ore dressing, either flotation, tabling, jigging, or all, and some actual mill experience. Will spend a little time at Florida plant, then in testing laboratory until thoroughly familiar with test methods and operations. Principal duties field trips to customers who installed pilot-plant test work to make sure they obtained the best results possible from such test work. Trips abroad might be necessary. Salary open. Colorado. W-8047.

ENGINEERS. (*a*) Design engineer with 10 years' experience designing and developing automatic business machinery, preferably tabulators, sorters, and card-punch mechanisms. Must have thorough knowledge of this field, including patent situation. $6500 year. (*b*) Development engineer experienced in hydraulics, servomechanism, and control devices, with at least 3 years' experience in hydraulic and electrical engineering. Capable of using higher mathematics for analytical purposes. Salary depending upon experience. (*c*) Engineer with heavy experience in electronics and some patent experience desirable. Salary open. New York, N. Y. W-8058.

PLANT MAINTENANCE ENGINEER, engineering education and experience, preferably both mechanical and electrical knowledge. Experience in textile or coated-fabric field desired. Responsibilities include direct supervision of all plant machinery and modifications of existing equipment. About $5000 year. Northern New Jersey W-8064.

PLANT ENGINEER with at least 10 years' experience in food processing and packing, preferably in canning of fish or oysters, to take charge of installation and operation of freezing and canning equipment for fisheries concern. $6000–$8000 year. West Coast of Mexico. W-8085.

SALES MANAGER, 40-45, with broad experience in sale of small cutting tools to jobbers and dealers in machine-tool fields. $10,000 year plus commission. Central Pennsylvania. W-8086.

PROFESSORS. (*a*) Professor to head department of machine design, with some teaching as well as industrial machine-design experience. (*b*) Professor of heat-power or aircraft-power work. $6000 year. Upstate New York. W-8092.

ENGINEERS. (*a*) Chief engineer with tool-design and product-engineering experience, to take charge for manufacturer of timing devices and meters. Will supervise 10 engineers and draftsmen. (*b*) Assistant superintendent with instrument, meter, or other small-device production experience, to be responsible for shop production. $8000–$12,000 year. Connecticut. W-8106.

COST ENGINEERING MANAGER, preferably graduate mechanical or industrial engineer, with experience in setting engineering standards for services, utilities, and expenses. Should also have some experience in preventative maintenance and scheduling repairs, etc. Excellent opportunity; will head up industrial-engineering department. $8000–$10,000 year. New York State W-8116.

ASSISTANT CHIEF DESIGN ENGINEER, 30-38, preferably mechanical graduate with some training in fluid mechanics. Should have at least 5 years' experience on the board as a designer, preferably with heavy rotating equipment, such as steam turbines, electric generators, steel-mill equipment, heavy equipment, heavy compressors, or gas turbines. Some experience in contacting vendors' representatives in securing agreement on design details and on technical questions. Should have actual experience on heavy-tool equipment or experience in planning operations on such equipment. Should understand the principle of organization of engineering department. Understanding of economics of heavy-equipment purchase and installation, and an acquaintance with methods of cost estimating desirable. Should be capable of supervision of 4 principal design groups; structural, hydraulic, special production, and valves. $8500–$10,000 year. W-8117.

PRODUCTION PLANNING AND SCHEDULING MANAGER, mechanical, with good background of production-planning experience, to see that production buying and inventory control are co-ordinated, for plant engaged in making simple metal products involving cutting, punching, and assembly. $6000–$7000 year. New Jersey. W-8121.

MARKET ANALYST to develop ideas from embryonic stage through market research to final production or discard for department handling development of proprietary items in plastics. Should have ability to contact the market and be familiar with high-pressure molding of plastics. Connecticut. W-8123.

DIRECTOR OF ENGINEERING to take charge of a designing staff of 250 for consulting firm doing wide variety of design work on machines, products, and structures for their clients. Candidate should approximate 45 to 50 years of age, have good executive ability to direct the staff, see that all promises are kept to clients, and be able to recognize good work when he sees it. Position permanent. Chicago. Up to $15,000 a year. R-3815.

William Prager Heads New Division at Brown University

THE appointment of William Prager, member A.S.M.E., professor of applied mechanics, to the chairmanship of a new graduate division of applied mathematics established at Brown University, Providence, R. I., has been announced. The new division, organized as an interdepartmental project of the departments of mathematics and physics and the division of engineering, is expected to help meet the needs of schools and research laboratories for engineers, physicists, and mathematicians, whose training extends beyond the accepted boundaries of their respective fields.

Other appointments to the new division are: John Henry Marchant, member A.S.M.E., professor of engineering; and George Francis Carrier, junior member A.S.M.E., assistant professor of engineering.

G. D. McCann Joins Faculty at California Tech

G. D. McCANN, junior member A.S.M.E., consulting transmission engineer, Westinghouse Electric Corporation, Pittsburgh, Pa., has joined the faculty of the California Institute of Technology, Pasadena, Calif., as associate professor of electrical engineering.

Dr. McCann assisted in the development of the fulchronograph for registering the amount of current in a lightning discharge and other instruments such as a magnetic surge-front recorder, magnetic surge integrater, and a magnetic oscillograph.

At California Tech he plans to build an analog computer in his analytic laboratory.

Candidates for Membership and Transfer in the A.S.M.E.

THE application of each of the candidates listed below is to be voted on after Dec. 25, 1946, provided no objection thereto is made before that date, and provided satisfactory replies have been received from the required number of references. Any member who has either comments or objections should write to the secretary of The American Society of Mechanical Engineers immediately.

KEY TO ABBREVIATIONS

Re = Re-election; Rt = Reinstatement; Rt & T = Reinstatement and Transfer to Member.

NEW APPLICATIONS

For Fellow, Member, Associate, or Junior

AAGAARD, E., Macon, Ga.
ALLEN, FLOYD B., Elmira, N. Y.
ARGUE, FRED W., West Newton, Mass.
BALLINGER, LOWELL H., San Mateo, Calif.
BATEMAN, THOMAS HUSTON, Philadelphia, Pa.
BEAR, FRED T., Wilmington, Del.
BERKENSTOCK, H. R., Abington, Pa.
BIRKNESS, HAROLD A., Newark, Del.
BLANK, FRANK F., Walcott, Iowa
BRENGEL, FREDERICK L., Hicksville, N. Y.
BRINKMAN, WILLIAM HARRY, Cincinnati, Ohio
BROWN, F. BARTON, Los Angeles, Calif.
BUTTINE, FRANK A., JR., Brooklyn, N. Y.
BYERS, JAMES E., Tulsa, Okla.
CAMPBELL, W. S., Akron, Ohio
CHENEY, AZRO J., JR., Upper Montclair, N. J.
CLOWER, JAMES I., Newark, Del. (Rt & T)
COGAN, LOUIS, New York, N. Y.
COHEN, D. B., Glen Cove, N. Y.
CONNELL, LLOYD L., Chicago, Ill.
CORNELIUS, H. W., JR., Philadelphia, Pa.
CROES, JOHN A., Knoxville, Tenn.
CROSS, RICHARD NELSON, Erie, Pa.
CUNNINGHAM, JOHN F., JR., Greensburg, Pa. (Rt & T)
DALAL, H. S., South Bend, Ind.
DERBY, NORMAN L., Glenbrook, Conn. (Rt)
DRAKE, HENRY B., JR., West Orange, N. J. (Rt & T)
DUNGLINSON, JOSEPH, JR., Danville, Va.

EMMER, ERWIN A., Cincinnati, Ohio
FABRIN, A. O., Memphis, Tenn.
FARMER, HORACE E., Grosse Pointe, Mich.
FEELEY, FRANK G., JR., Larchmont, N. Y. (Rt)
FISHWICK, HORACE P., Hanover Center, Mass.
FLORESKUL, STANLEY, V. W., Roslindale, Mass.
FOWLER, FRANK B., White Plains, N. Y.
FOX, OSCAR E., York, Pa.
FRASER, NORMAN, New York, N. Y.
FRAZIER, PHILLIP M., Columbus, Ohio
GASSAWAY, J. SCOTT, Los Angeles, Calif.
GEIST, PAUL M., Bridgeport, Conn.
GOODRICH, S. J., Brooklyn, N. Y.
GRANIERI, PETER P., JR., Providence, R. I.
HAIGH, L. C., Short Hills, N. J.
HANSEN, WILLIAM C., Pittsburgh, Pa.
HARDY, ALFRED W., Staten Island, N. Y.
HAWES, GEORGE H., JR., Elmira, N. Y.
HENLEY, R. G., Roanoke, Va.
HENNESSY, GEORGE W., Chicago, Ill.
HENRIKSON, THOR, Renton, Wash.
HERKLOTZ, RUDY E., Ferndale, Mich.
HEUGHAN, D. M., Dewsbury, Yorks, England
HEYWOOD, WALTER T., Long Beach, Calif.
HOLZ, CHARLES P., Charleston, W. Va.
HOUSER, O. G., Tulsa, Okla.
HOYE, FRANCIS W., Seattle, Wash.
IRELAND R. L., Cleveland, Ohio
JACKSON, WILLIAM H., Philadelphia, Pa. (Rt & T)
JOHNSON, H. EUGENE, Tonawanda, N. Y.
JORDAN, R. C., Minneapolis, Minn.
JUDISCH, CARL H., Hamden, Conn.
KACZYNSKI, EDWARD, Syracuse, N. Y.
KANN, A. G., Chicago, Ill.
KAVANAGH, F. W., Richmond, Calif.
KERVEN, DANYAL N., Schenectady, N. Y.
KING, BENJAMIN F., Charleston, W. Va.
KORN, KARL E., Oak Ridge, Tenn.
KROOG, ALFRED J., Decatur, Ga. (Rt & T)
KYLE, R. E., Mishawaka, Ind.
LACERENZA, JOSEPH A., New York, N. Y.
LAMB, ROBERT WAYLAND, Newburgh, N. Y.
LANDSBERG, R. D., Wilmington, Del.
LANE, RICHARD ADAMS, Lansdowne, Pa.
LEE, KWANG HWA, Denver, Colo.
LISSOON, MICHAEL, Brooklyn, N. Y.
LOBBEN, WILLIAM, Oslo, Norway
LOW, EMERY M., Rochester, N. Y.
LUTH, ROBERT C., Chicago, Ill.
MAC QUILL, C. E., Columbus, Ohio
MALETZ, M., Milwaukee, Wis. (Rt)
MANNEY, JAMES D., Elmira, N. Y.
MCCLAY, A. W., JR., Richmond, Va.
MCFARLAND, CLAY, San Antonio, Texas
MCGREGOR, L. S., Toronto, Ontario, Can.
MCMILLAN, A. K., JR., Great Neck, N. Y.
MEREFIELD, K. E., Croydon, Surrey, England
MICHELSEN, HENRY HAYES, Rochester, N. Y. (Rt)
MIDDLETON, J. EDWARD, Winnetka, Ill.
MIXON, THOMAS M., Baton Rouge, La.
MONROE, KENNETH C., Detroit, Mich. (Rt)
NISBET, E. B., Glenbrook, Conn.
NOYES, TRIGG, Sanford, N. C.
PAPPAS, STEVE L., University, Ala.
PARKER, JOHN, Storrs, Conn. (Re)
PARSONS, CLAUDE P., Houston, Texas
PATEL, F. N., Pittsburgh, Pa.
PERRY, HOWARD M., Portland, Oregon
PETIT, R., Tientsin, China
PIERCE, CHARLES I., Barstow, Ill.
POORMAN, S. L., Wilmerding, Pa.
POTTERTON, SANFORD T., Upper Montclair, N. J.
PRENTICE, B. R., Schenectady, N. Y.
PRYKE, JOHN, New York, N. Y.
RAVENSCROFT, ROBERT W., Alameda, Calif.
ROSENBLUM, PHILIP, Deal, N. J.
ROSS, GEORGE F., Monaca, Pa.
RYON, RICHARD C., Garden City, N. Y.
SALZMANN, F., Zurich, Switzerland
SANDAL, C. H., Oakland, Calif.
SEGAL, P., Montreal, Quebec, Can.
SHAWHAN, OLEN BYRON, Riverside, Ill.
SIEVERT, O. MORRIS, Ridgway, Pa.
SINCLAIR, WILLIAM, Detroit, Mich.
STODDARD, ROBERT J., St. Paul, Minn.
STRINGER, GEORGE, Madison, N. J.
TAFF, FREDERICK N., JR., Naugatuck, Conn.
THOMES, EDWIN J., Milwaukee, Wis.
THOMPSON, EUGENE W., JR., New London, Conn.
TING, LI TE, Newark, N. J.
TOWERS, RICHARD R., Philadelphia, Pa.
TOWERY, JACK D., Plymouth, Mass.
VAN DE PUTTE, CHARLES, San Antonio, Texas
VERCOE, JOSEPH E., Beloit, Wis.
VILAS, FRANKLIN E., New York, N. Y. (Rt & T)
VREUDENBURG, ALBERT J., Bristol, Pa.
WARGO, ERNEST EDWARD, Cleveland, Ohio
WARREN, FRED H., Findlay, Ohio (Rt & T)
WATTSON, ROBERT K., JR., Stillwater, Okla.
WEHRLEIN, R. F., New York, N. Y.
WIDNESS, E. M., Lynbrook, N. Y.
WILLMS, HENRY C., Malvern, Ark.
WINDENBURG, DWIGHT F., Washington, D. C.
WINSTON, A. W., Midland, Mich.
WOLFE, PAUL E., BALTIMORE, Md.
YEO, ERNEST E., Salem, Mass.
ZIPAY, ALBERT J., Clifton, N. J.

CHANGE IN GRADING

Transfers to Fellow

ARMITAGE, JOSEPH B., Milwaukee, Wis.
BROWN, CARL D., Hopedale, Mass.
THOMPSON, SANFORD E., Newton Highlands, Mass.

Transfers to Member

BACHMAN, GERALD G., Omaha, Nebr.
BICE, GRAHAM WILLIAM, New York, N. Y.
CAMPBELL, JAMES P., Long Beach, Calif.
DAWSON, LEWIS J., Phillipsburg, N. J.
DE MAURIAC, WILLIAM J., II, Springfield, Pa.
DENNIS, RICHARD E. (LIEUT.), Terre Haute, Ind.
DONNELLY, FRANCIS J., Baldwin, N. Y.
FITZHUGH, R. R., Nicaro, Cuba
GLISS, GEORGE E., Baltimore, Md.
HAMILTON, SAMUEL L., Miami, Fla.
HEWLETT, ALLEN M., Hawaii, T. H.
JOHNSON, EDWARD ANDREW, Providence, R. I.
LANCAON, JUAN SILVA, Manila, P. I.
LARSON, JOHN A., Oakland, Calif.
LOMAX, BURT, JR., Nashville, Tenn.
MAYBEE, B., Peterborough, Ontario, Can.
OTOCKA, E. A., Summit, N. J.
PEARSON, JOHN E., Urbana, Ill.
SALECKER, ANTON, Syosset, N. Y.
SCOTT, DONALD C., Wilbraham, Mass.
TARALLO, D. RICHARD, Palisades, N. J.
TIZARD, THOMAS E., Inspiration, Ariz.

Transfers from Student Member to Junior.....60

LeRoy Salsich Awarded A.I.M.E. Medal

THE Lawrence Saunders Gold Medal for 1947 of the American Institute of Mining and Metallurgical Engineers has been awarded to LeRoy Salsich, president, Oliver Iron Mining Company, Hibbing, Minn.

The award was made in recognition of his success in developing men and methods for the mining and transportation of iron ore; and his contribution, as operating head of one of the largest iron-mining enterprises in the nation, to the production of steel, vital to victory in World War II.

The medal will be presented to Mr. Salsich during the annual meeting of the A.I.M.E. to be held at the Waldorf-Astoria Hotel, New York, N. Y., March 17-19, 1947.

Necrology

IT is urged that the Society be notified promptly of the deaths of members and that the date of death be given for announcement in MECHANICAL ENGINEERING. Complete memorial biographies are published in the Society Records (Section Two of Transactions), and relatives, business associates, and Society officers and members are requested to send newspaper clippings or information in any other form which will be useful in the preparation of such biographies. A special biographical data sheet for supplying complete details will be furnished by the headquarters office upon request.

FRANCISCO, FERRIS L., October 11, 1946
HOBART, HENRY M., October 11, 1946
LUCAS, JOHN W., September, 1946
PARKER, JOHN CLINTON, October 9, 1946
SIBSON, HORACE E., September 18, 1946
WEBER, AUGUST, JR., July 26, 1946
WOOLSON, CLIFFORD G., September 29, 1946

A.S.M.E. Transactions for November, 1946

THE November, 1946, issue of Transactions of the A.S.M.E. contains the following papers:

The Escher Wyss-AK Closed-Cycle Turbine, Its Actual Development and Future Prospects, by Curt Keller

The Influence of Viscosity on Centrifugal-Pump Performance, by A. T. Ippen

The Theory of Moving Sources of Heat and Its Application to Metal Treatments, by D. Rosenthal

Cutting Action of Reamers, by T. F. Githens

Utilization of Producer Gas in Industrial Furnaces, by D. B. Hendryx

Pulsation and Its Effect on Flowmeters, by E. J. Lindahl

Boiler Design for Extreme Load Variations, by M. H. Kuhner

Acid-Cleaning of Boilers and Auxiliary Equipment, by S. T. Powell